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Symmetrical Proportion Charts for the Adult Female Body

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IN THE field of corrective exercise, more complete knowledge of the effects upon each area of the body of each exercise taught should and does give more rapid results. Properly chosen methods of measuring are almost essential aids in acquiring this information and thereby developing advantageous techniques.

There are, of course, many types of measurement available and being used in physical education and physical therapy. One of these, the measurement of body circumferences, as will appear in the course of the discussion, not only is useful and effective in planning and evaluating exercise programs but also possesses the advantages of simplicity and accuracy.

Since the muscles are responsible to such a great extent for the shape of the body, there is a close correlation between physical appearance and muscular condition. After experience has been gained, quite accurate deductions can be made regarding the strength merely by observing the body contours. Also, with training visible changes occur in the shape of the muscles. A fertile field is thereby presented for study and analysis.

Insofar as muscular strength is important as a health factor, body proportions are indicative of general conditions—a bulging abdomen does not indicate a prospective long life span. In fact, the relative *proportions* are probably of far greater physiological significance than the mere measure of the total bulk; weight is secondary to the interrelationship in size of the various body segments.

The determination of the optimum proportions for the adult woman by a new approach is one of the results of the measurements which have been taken over a period of upward of a dozen years.

In considering body proportions, various aspects must be taken into account:

1. The relative proportion of the dimensions of a segment as a separate entity. For example, the size and shape of the calf, ankle, and foot as components of the lower extremity.

2. The relative proportion of the segments to each other and the body as a whole. While the size and shape of a particular segment might be correct when considered alone, it may be out of balance with the rest of the structure.

PURPOSE OF THE STUDY

Specifically, the present purpose is to determine both symmetrical proportions of the adult female body relative to certain measurements of the skeleton and the optimum distribution of the flesh over the figure. In doing this a consistent set of ideals for many of the body circumferences is worked out, and from it, optimum proportions can be determined.

By comparison of the measurements of a particular individual with the ideals, deviations from the ideal are apparent, and the areas which need attention most urgently are clearly indicated.

Furthermore, the efficacy of the procedures used for improvement may easily be evaluated by comparing the changes between successive sets of measurements made in the course of the program.

Such comparisons are of great psychological value both to pupil and instructor. Since the measurements are those of his own body, the pupil's interest in them and their changes is naturally intense. Their definiteness and ease of comprehension enhance their value for this purpose.

And measurements act as an incentive for the instructor to improve his methods, as progress in this direction can be determined by actual figures. And by working with the strong and healthy, techniques can be found by which the weaker may be more certainly and more effectively helped.

The Term "Ideal."—In general usage, an "ideal" is thought of as ultimate perfection. In the case of body proportion, it might be a set of measurements based on any one of several criteria, to all of which it is conceivable no human being could ever conform.

For example, fashion artists habitually use proportions in drawing their mannequins that very few, if any, women ever could attain. If the Venus de Milo is set up as the ideal, it would obviously be impossible to bring every woman to her conformation.

The physician, considering the shape of the pelvis in the light of possible difficulty in childbirth, may set up an entirely different ideal. The athletic coach evaluating the individual in terms of acrobatic or physical performance visualizes yet another ideal.

Now the structure of the skeleton itself sets some of the fundamental proportions, and these are not capable of great modification. It follows that practical difficulties or inconsistencies may well result from trying to use such ideals.

These difficulties may be resolved by defining ideal as an objective ordinarily attainable by normal bodies in good physical and muscular condition. It is, therefore, in this restricted sense that the term will be used.

Tolerances.—To take care of variations in bony structure, ideal measurements must include a bracket of acceptable tolerances. Then if

all the measurements of an individual fall within her tolerance brackets, her proportions may be considered as excellent. This approach makes the "ideals" practical and attainable rather than theoretical. They are objectives which it is expected may be met in the great majority of cases with an efficacious system of specific, corrective exercise, unless pathological or other abnormal conditions exist.

Since one of the most important reasons for having tolerances is to take care of the skeletal deviations, which no exercise program can hope to change in the adult, the ideal measurements which are derived may be inapplicable if the skeleton itself is abnormal, either as the result of injury or a pathological condition. If a particular bone is atrophied or abnormally thickened or enlarged, then the ideal probably cannot be attained. This may also be true in certain cases of kyphosis, or such deformities of the chest cage as pigeon breast. Also, habitual segment deviations, particularly when they are large, may affect adversely the possibility of attaining ideal proportions.

Diameters and Circumferences.—In measuring a body cross section it is possible to determine either the diameters, using large sliding compasses or calipers, or the circumference, using a steel tape.

The formula relating the major and minor diameters of an ellipse to the circumference is:

$$\pi(a+b)K$$

For $m =$	0.1	0.2	0.3	0.4	0.5	0.6
$K =$	1.002	1.010	1.023	1.040	1.064	1.092

$$m = (a-b)/(a+b)$$

It is fairly accurate even for ellipsoidal or ovoidal shapes approximating an ellipse.

More important, however, is that from the standpoint of accuracy, the circumference is preferable. Using ordinary observational care, about the same accuracy is to be expected in measuring either the perimeter or diameter. Owing to the multiplying factor π, the accuracy is about three times as great if circumferences are measured rather than diameters.

For these two reasons, it is felt that the circumferential measurements are to be preferred, and the data were accordingly taken in this way.

Certain Limitations of Circumferences When Used Alone.—It is appreciated that several different combinations of diameters will give the same circumference. Therefore the section being measured might be quite misshapen and yet have the ideal perimeter. Such a situation can easily be taken care of by observation.

Also, the circumferences of the knee, calf, and ankle might be correct, and yet the contour of the leg between these three circumferences may be quite far from pleasing. The curvature might be wrong, or the two legs quite unlike in shape. Furthermore, there seems to be no simple

method of measuring the curvature between the selected cross sections. To take care of this difficulty as far as possible, it may be necessary in such cases to make qualitative observations of proportion, shape, and symmetry.

The Advantage of "Circumferences Plus."—If two adjacent measurements such as the calf and ankle are in suitable ratio, the likelihood of a poorly shaped leg is less than if they were considered as independent measurements. If one is at the lower range of its tolerance bracket, and the other at the high extreme of its tolerance, it is easy to visualize the result. Experience has led to the conclusion that in such cases, both circumferences should differ similarly from the mean, i.e., either both above it, or both below. Cases have been observed where the individual had considerable amounts of excess flesh, and yet because it was well distributed and not concentrated in a small area the body would be rated as having good proportions, even though it did not come within the ideals.

Choice of Fundamental Variable.—Although the bony structure is the determining factor in setting the ideals for a particular individual in some instances there is so much fat it is difficult to ascertain just where the bones are. How great a help an inexpensive, dimensionally accurate X-ray picture would be in such cases! However, even with excessive overweight, one fundamental dimension which is independent of the fat deposits can still be measured—the height. For this reason, it is chosen as the fundamental variable. Certain exceptions and difficulties in its use will be mentioned, but they do not invalidate the general conclusion that it is the best choice.

One of these is that although the length of the bones is fixed in adults, the length of the spine can and does vary depending upon the amount of extension. These changes of course affect the standing height. Clearly, for determination of an individual's ideals, the desired length is that when she is (or will be) in good extension. It is nearly always possible to obtain this quite closely by taking the measurements in the supine position with the spine fully extended.

SURVEY OF PREVIOUS WORK

Two tables of ideal measurements of the human body have come to our attention, which serve to illustrate some of the difficulties encountered in trying to construct sets of ideals. One is in McFadden's *Encyclopaedia of Physical Culture,* and the other from a booklet *Scientific Weight Control.* These have been plotted and show that in all cases, as the height increases the circumferences tend to increase according to a strict linear law. Some points are high and others low, however, indicating that the ideals were probably set up by adding constant differences to the circumferences as the height increased.

A more interesting observation is that these tables do not agree,

for example, in the ideals for the hips. The determination of which, if either, is correct is beyond the present purpose.

A more scientific approach is made by Willoughby[1] who discusses standards and optimal proportions for *any* individual in terms of the "corrected" girth of the ankle. He points out the lack of complete correlation of weight of the body and the optimal proportions, and finds that when *six* measures, representing the degree of skeletal thickness in various parts of the figure, are incorporated or converted into a single size-unit, that unit may dependably be adopted as a basis from which to determine and prescribe *all* the girth and diameter measures of the body and (with the measures of stature) the weight.

The six measurements he used were: breadth of shoulders (bi-acromial diameter), breadth of pelvis (bi-iliac diameter), breadth of hips (bi-trochanteric diameter), girth of wrist (average of right and left), girth of knee (average of right and left), and girth of ankle (average of right and left). From these is derived a "corrected ankle girth" as a representative value of the skeletal thickness. The ideals for other measurements are various constants times the corrected ankle girth.

The agreement between certain of Willoughby's data and that presented here will be pointed out later.

The idea of tolerances which makes the use of ideals practicable does not appear in any of these. It is of course old in other fields such as engineering and machine design.

SCOPE OF THE DATA

The data have all been taken on adult women, by which is meant those possessing a mature configuration, regardless of actual age. Also, no correction in these ideal measurements has been made for increasing age, as it has been found possible in almost every case to obtain the valuable results of specific exercise up to ages in the early 60's. It is understood, of course, that for the older individuals the changes are not so rapid as for younger women.

Thus far the study has been limited to the female body, and, furthermore, has not been extended to children.

THE MEASUREMENTS

It is possible to determine ideals in several ways. One of the first which comes to mind is to measure a large number of women and find the average of the distribution and assume a reasonable deviation as tolerable. The present objective, however, is to determine limits for a superior class which may differ considerably from the average of an

[1] David P. Willoughby, "An Anthropometric Method for Arriving at the Optimal Proportions of the Body in Any Adult Individual," RES. QUART., 3:1 (March 1932) 48.

unselected group. This necessitates choosing those upon whom the measurements are made.

This has been accomplished as follows: Measurements have been taken on a considerable group of healthy women over a period of more than twelve years of work in a specialized branch of corrective exercise. Some were overly fat, many had generally good bodies, with only certain measurements out of proportion and a few were too thin.

After initial measurements, each of the group was given a program of exercises individually planned for her.

The exercises were designed to improve the physical condition, to remove excess tissue where present, and to develop the weak muscle groups. If these are effective (as in past experience they have been) she will tend to approach more nearly ideal proportions.

If then we select a particular case where a dimension (say the waist) was obviously too large initially and another case where the same dimension was too small, it seems reasonable that with exercise both measurements should approach the bracket within which bodies in good physical condition tend to lie. This bracket should include, as it does, the measurements of those women whom we please to call well proportioned.

It is obvious that the result is a table of ideal measurements, together with tolerable variations from them, and not the "average" measurements of the height-weight tables. By the method of determination, furthermore, it may be used to establish ideal proportions which women's bodies, if effective exercises are given, should approach.

Location.—The measurement technique used has been described by Wanda Bowman-Wilson in "Measurements in Physical Education and Physical Therapy."[2]

The location of the measurements is as follows:

Neck—Base of neck, at the level of the sixth cervical vertebra.

Chest—Underneath the arm, arms normal.

Bust—This measurement is satisfactory only if the breasts are not pendulous. The nipple should be at the level of the fifth thoracic vertebra.

Upper Arm—Maximum circumference obtained below the insertion of the deltoid muscle.

Lower Arm—Maximum circumference just below the elbow.

Waist—Below the last rib. This should be the minimum circumference.

Abdomen—At the crest of the ilia at the sides and the fourth lumbar vertebra in the rear. This circumference tends to vary considerably due to such factors as digestion, fatigue, and mental condition. To obtain duplicable data for determining ideals, these factors must be

[2] *The Physiotherapy Review*, 15:5 (1935).

eliminated or compensated so far as possible. The present measurements were taken in the standing position upon individuals in generally good condition. While the variation might be somewhat less in the hanging position, this was not done for the data to be presented, as it might well be inconvenient always to make the measurements under these conditions. Facility of use was deemed of more importance than extreme accuracy.

Hip—Several measurements have been found useful. One is at the level of the symphysis pubis in front. In determining the circumference, care should be taken that the tape is level all the way around. A second is at the great trochanters. This should be the maximum circumference. If it is not, then a measurement is taken at the maximum circumference. This is the value used in the tables.

Upper Thigh—Just below the gluteal fold. This should be the maximum circumference.

Lower Thigh—Just above the knee-joint. This should be the minimum circumference.

Calf—Maximum circumference.

Ankle—Above the malleoli.

The cross sections at which measurements are taken are definite, easy to find, and accurately duplicable. In general, they use the landmarks outlined in Hrdlicka's work on anthropometry.

It will be noted that in most instances the bones or the origin or insertion of muscles are used, but in a few cases, the maximum or minimum measurement is taken. Thus, the ankle circumference is taken directly above the malleoli; the upper arm is taken at the insertion of the deltoid, with the arm held horizontal; the calf is measured at the maximum; and the waist is the minimum measurement directly below the ribs. The hip permits of at least two measurements using the bony prominences as landmarks.

Equipment and Technique.—A steel tape measure was used. Care was taken to check the measurements by taking two independent measurements of each circumference.

Accuracy.—The accuracy in the smaller sizes is probably better than $\pm\frac{1}{8}$ inch, and on the larger $\pm\frac{1}{4}$ inch. This includes the effect of different tensions on the tape measure at different times.

The percentage accuracy is 1.5 or better. This is ample for the purpose, and compares favorably with engineering data.

SOURCE OF THE DATA

To obtain the basic data, from the files of Wanda Bowman-Wilson were taken the records of a number of women of varying heights. Since the objective was to set up tolerance brackets, cases were selected for study which gave a maximum of useful information on this point. Well proportioned individuals served to check the average. The most valu-

able cases in setting the limits were those which, in the opinion of the observers, came into the borderline classification. These were just within or slightly outside the proposed tolerances. The data gave the initial and periodical measurements during a program of exercise, together with the changes. As a first step they were tabulated so that all the measurements of women of the same height were together.

Number of Cases.—The original work on the problem of ideals was done several years ago for the ankle, calf, thigh, waist, bust, chest normal (not expanded), neck, and upper and lower arm measurements. These have been used continuously since and therefore checked for accuracy on a considerable number of people. Thus far, with only minor adjustments, they seem to meet the objective originally set of being attainable by individuals in normally good condition.

However, experience indicated the desirability of adding ideals for the abdomen and lower thigh, i.e., just above the knee. While this was being done a survey was made of the original data and additional cases were added to those heights which had somewhat less material, so that the final results for the group of measurements mentioned above are based on a distribution as follows:

Height	No. Cases	Height	No. Cases	Height	No. Cases	Height	No. Cases
5′0″	10	5′2½″	6	5′4½″	9	5′7″	14
5′½″	4	5′3″	8	5′5″	9	5′7½″	3
5′1″	9	5′3½″	3	5′5½″	5	5′8″	2
5′1½″	4	5′4″	9	5′6″	5	5′8½″	1
5′2″	8			5′6½″	3		

In the case of the lower thigh, data were collected for about six cases at each inch of height. This was deemed adequate since two measurements are available from each case and, of course, with symmetrical development these should be equal.

In the case of the abdomen, owing to the fact that this measurement was not originally taken, somewhat fewer cases were available for analysis. These were distributed as follows:

Height	No. Cases	Height	No. Cases	Height	No. Cases	Height	No. Cases
5′0″	4	5′2½″	4	5′4½″	6	5′7″	0
5′½″	3	5′3″	6	5′5″	8	5′7½″	3
5′1″	6	5′3½″	3	5′5½″	4	5′8″	0
5′1½″	3	5′4″	3	5′6″	5	5′8½″	1
5′2″	4			5′6½″	2		

However, it is felt that due to an internal check of the data to determine whether these were consistent with other measurements they may be used with confidence.

Age Distribution.—The women's ages varied from the late 'teens to the early 50's. The great majority, however, were in the group from 22 to 35, with relatively few at the extreme limits of the range.

Weight Distribution.—The great majority before exercise were within ten pounds of what is usually considered normal weight.

Many more were found to be overweight than under. However, a sufficient number were below the ideals to give assurance that the lower limits are reasonably accurate.

Plotting and Smoothing the Data.—First a work sheet was plotted for each circumference which showed the initial measurement, the final measurement, and the direction of movement with exercise. These confirmed our previous ideas that with few exceptions the circumferences tended to become larger as the height increased.

For each particular height, several cases were available and at least two measurements for each. These, of course, were scattered over a considerable range. Some of the measurements (particularly the initial ones taken before exercise) were well above what could ever be considered as ideal. A considerable number (including many of those after exercise) fell in a cluster. A somewhat smaller number were below the group.

Even a casual inspection of the plot, however, quickly showed the extreme boundaries of the region in which the ideals for that height must lie. The range might be perhaps 10 per cent in width. The problem thus resolved itself into determining exactly where in the 10 per cent bracket the average should lie and how wide the tolerances should be.

A similar procedure was followed for each height. As this was done, the area in question became better delineated.

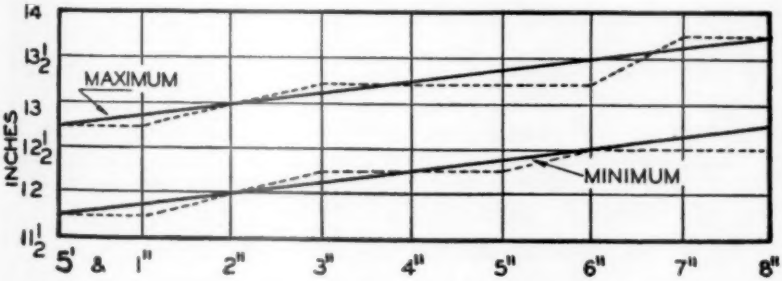

FIG. I. An example showing how the data were smoothed (calf measurement). Dotted lines show first tentative limits, solid lines the final smoothed limits.

Next a tentative upper and lower limit was chosen for each ordinate, checking to be sure no case obviously not near ideal was included. For some of the heights, no case was near the preliminary margins of the area. In such instances, those heights were temporarily disregarded, and only the points for which more certain data were available were used. These were joined by straight lines as shown in Figure I. The

area thus enclosed shows a fair approximation to the diamond-shaped figure expected. The limits are rather close, in the order of 3 or 4 per cent.

To smooth the data a straight line was then drawn for the upper and lower groups of points, as the limits of tolerance. This was chosen to fit the tentative points for each height as closely as possible.

The tentative choice of limits were subjected to several checks. First of all, each individual measurement which fell near the edges of the tolerance bracket was checked. Recourse was taken to consultation with other members of the staff in doubtful cases. The individuals upon whom the basic data were taken were known both to the person doing the work and to the others who assisted in the decisions. This, it is felt, enhanced the accuracy of the conclusions.

As a second check, the direction of movement with exercise of each individual was examined to see whether it pointed toward the area finally chosen. This was helpful as even those cases where the work was not completed could be used to confirm the choice of limits.

Such minor adjustments were made as these checks indicated were desirable.

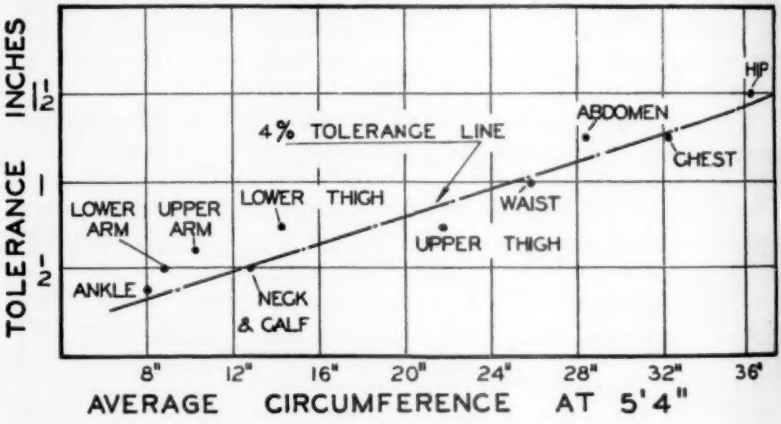

FIG. II. Permissible tolerance as a function of the circumference.

After all tolerance brackets had been determined independently these were plotted as shown in Fig. II. It was found that they showed considerable consistency among themselves. That is, data taken on different circumferences, when analyzed and the ideal bracket set up, showed about the same percentage limits of tolerance.

The Correlation of Arm Measurements and Height.—In almost all instances, the ideal circumferences increased with the height. Certain exceptions were found, however. The data for the upper arm are typical of the situation in the case of the arm measurements. While there may

be some variation with height, within the accuracy of the data, it is uncertain whether it is present or not.

If our fundamental principle is correct, that the circumferences are correlated most closely with the length of the long bones, then the circumferences of the arm would be most closely tied to the humerus and radius and ulna. These are not measured in the height determination. The correlation will therefore be lower with height than the other circumferences. Of course, a tall person will usually have longer arms than a short person, but this is not necessarily so. While this explanation is plausible, the fact remains the data indicate that for the present the accuracy tolerances should be independent of the height.

The Bust Measurement.—For the measurements of the bust, the original data plotted as a function of height were such that it was practically impossible to draw suitable tolerance limits consistent with those of the other circumferences of about the same size. It was only

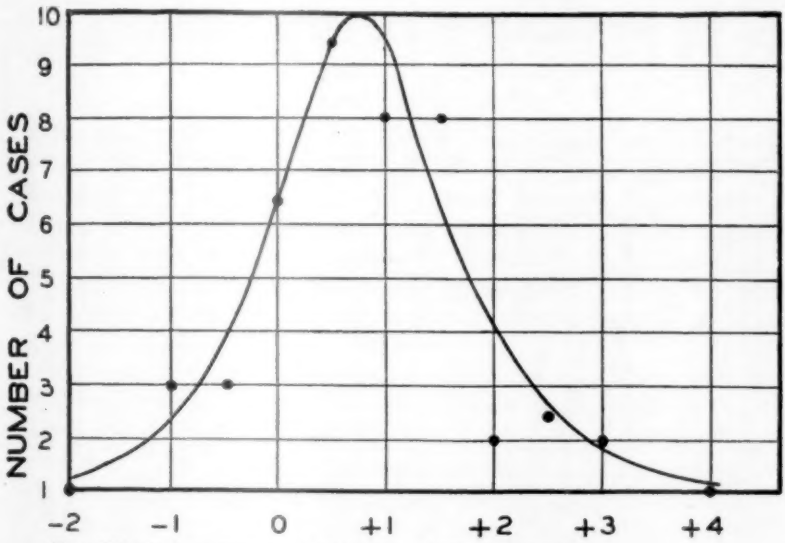

FIG. III. Inches excess of bust over chest measurement.

after considerable thought that this problem was broken down into two components. If the chest measurement is subtracted from the bust measurement, and the resulting data grouped in cells in the usual method for handling statistical material, in order to obtain a smooth curve, the distribution is shown in Fig. III.

This shows the bust measurement should be about ¾″ larger than the chest, whatever it may be, which is in accord with the anatomical facts involved, since the bust is a glandular and fatty deposit upon the chest.

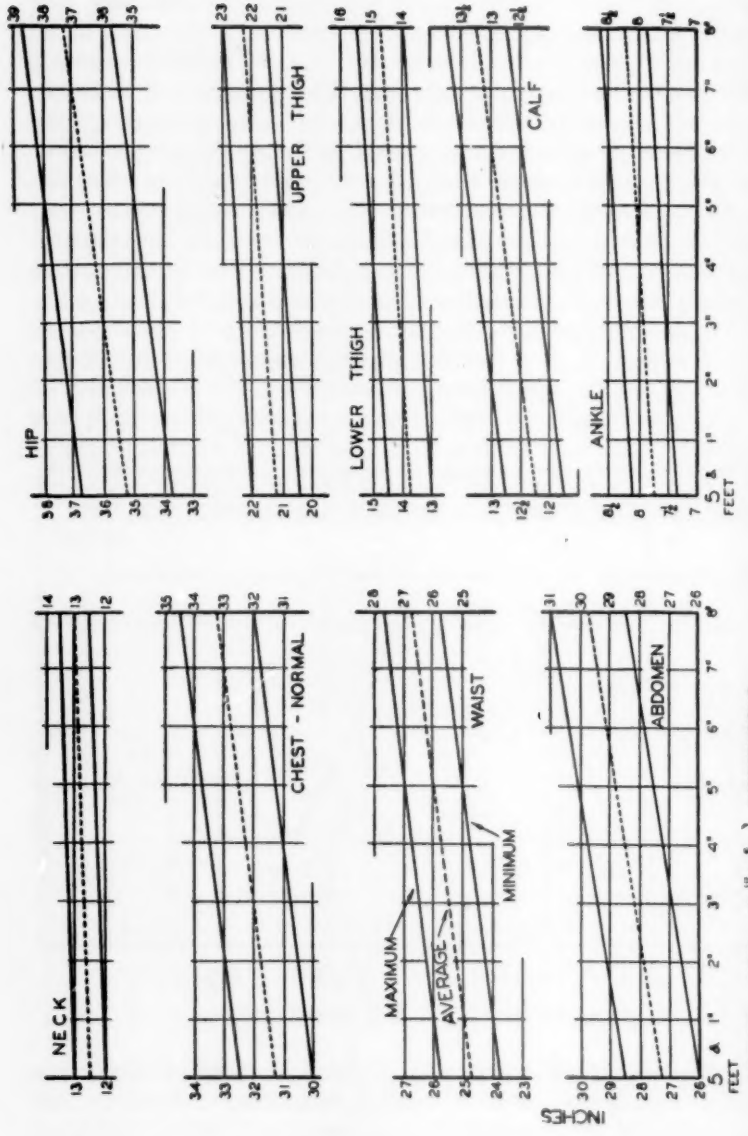

FIG. IV. Ideal proportions for women.

It is, therefore, possible to obtain a correlation of the bust measurement with the height, since the chest is related to it. However, in using this ideal it must be remembered how it was derived. Either one or the other of the two components may be out of limits, yet the

sum may be correct. A large bust on a small chest, or vice versa, is still not to be considered as ideal.

Relative Proportions and "Taper."—When this work had been completed, the preliminary results were plotted in chart form and also tabulated in order to facilitate a study of relative proportions of "taper" between two adjacent measurements such as the chest and waist, or calf and ankle.

Tables were then prepared showing these differences between adjacent measurements for the maximum, average, and minimum limits of tolerance for three heights, 5′0″, 5′4″, and 5′8″.

These "tapers" gave a further check on the validity of the ideals. The records and appearance of various women having relative proportions exceeding, within, or below the tentative tolerances were checked. Only a few small shifts of a fraction of an inch for certain heights in the ankle and calf measurements seemed appropriate .

The final results for all the circumferences are shown in chart form in Fig. IV, and also in tabular form (which is somewhat more convenient to use), in Table I.

DISCUSSION OF THE DATA

The data used in this study comprise several thousand measurements, some initially above the ideal and others below. Almost without exception, when carefully chosen specific exercises were given, all of them moved in the direction of the ideals. This trend is confirmed by data on other individuals which were not used in the present study.

In substantially every case the change has begun after only a limited number of exercise periods, provided these are fairly close together (on the order of three a week).

The exceptions that have been noted in an experience extending over about thirteen years have been certain small-boned women in poor muscular condition, whose measurements were below the ideal. In a few of those cases there has been a temporary drop in size as the tonus was improved, but as the muscles developed into good condition, the direction of change reversed, so that they too, finally, confirmed the trend. It may, therefore, be stated with considerable confidence that carefully administered specific exercise will change the measurements and in substantially every case in the direction to make them approach the ideal tolerance bracket.

Some of the circumferences, the chest, for example, are set largely by the conformation of the skeleton. On the other hand the flesh largely controls the circumference of the upper thigh since the femur occupies a relatively small portion of the total area. It follows that certain of the measurements are much more subject to change as a result of improved physical condition than others.

Amount of Tolerance.—It will be noted that the tolerances do not

TABLE I

Ideal Proportions for Women

Height 5′ and	Neck Min.	Neck Av.	Neck Max.	Chest Min.	Chest Av.	Chest Max.	Bust	Waist Min.	Waist Av.	Waist Max.	Abdomen Min.	Abdomen Av.	Abdomen Max.	Hip Min.	Hip Av.	Hip Max.
0″	12	12½	13	30	31¼	32½		23¾	24¾	25¾	26	27¼	28½	33½	35¼	36½
½″	12	12½	13	30⅛	31⅜	32⅝		23⅞	24⅞	25⅞	26⅛	27⅜	28⅝	33⅝	35⅜	36⅝
1″	12	12½	13	30¼	31½	32¾		24	25	26	26¼	27½	28¾	34	35½	37
1½″	12⅛	12⅝	13⅛	30⅜	31⅝	32⅞		24⅛	25⅛	26⅛	26½	27¾	29	34⅛	35⅝	37⅛
2″	12¼	12⅝	13⅛	30½	31¾	33		24¼	25¼	26¼	26⅝	27⅞	29⅛	34¼	35¾	37¼
2½″	12⅜	12⅝	13⅜	30⅝	31⅞	33⅛	Chest measurement plus ¾″ average ¼″ minimum 1¼″ maximum	24⅜	25⅜	26⅜	26¾	28	29¼	34⅜	35⅞	37⅜
3″	12⅜	12⅝	13⅜	30¾	32	33¼		24½	25½	26½	26⅞	28⅛	29⅜	34½	36	37½
3½″	12½	12½	13½	30⅞	32⅛	33⅜		24⅝	25⅝	26⅝	27⅛	28⅜	29⅝	34⅝	36⅛	37⅝
4″	12½	12⅝	13½	31	32¼	33½		24¾	25¾	26¾	27¼	28½	29¾	34¾	36¼	37¾
4½″	12½	12⅝	13½	31⅛	32⅜	33⅝		24⅞	25⅞	26⅞	27⅜	28⅝	29⅞	34⅞	36⅜	37⅞
5″	12½	12¾	13½	31¼	32½	33¾		25	26	27	27½	28¾	30	35	36½	38
5½″	12⅝	12⅞	13⅝	31⅜	32⅝	33⅞		25⅛	26⅛	27⅛	27¾	29	30¼	35⅛	36⅝	38⅛
6″	12⅝	12⅞	13⅝	31½	32¾	34		25¼	26¼	27¼	27⅞	29⅛	30⅜	35¼	36¾	38¼
6½″	12⅝	12⅞	13⅝	31⅝	32⅞	34⅛		25⅜	26⅜	27⅜	28	29¼	30½	35⅜	36⅞	38⅜
7″	12¾	12⅞	13¾	31¾	33	34¼		25½	26½	27½	28⅛	29⅜	30⅝	35½	37	38½
7½″	12½	13	13½	31⅞	33⅛	34⅜		25⅝	26⅝	27⅝	28⅜	29⅝	30⅞	35⅝	37⅛	38⅝
8″	12½	13	13½	32	33¼	34½		25¾	26¾	27¾	28½	29¾	31	35¼	37¼	38¾
Tolerance	±½″			±1¼″			±½″	±1″			±1¼″			±1½″		

Taper Tolerances

Height 5′ and	Neck-Chest Min.	Neck-Chest Av.	Neck-Chest Max.	Chest-Waist Min.	Chest-Waist Av.	Chest-Waist Max.	Abdomen-Waist Min.	Abdomen-Waist Av.	Abdomen-Waist Max.	Hip-Abdomen Min.	Hip-Abdomen Av.	Hip-Abdomen Max.	Hip-Upper Thigh Min.	Hip-Upper Thigh Av.	Hip-Upper Thigh Max.	Upper-Lower Thigh Min.	Upper-Lower Thigh Av.	Upper-Lower Thigh Max.
0″ to 7″	18⅜	18¾	19⅛	6¼	6½	6¾	2¼	2½	2¾	7¾	8	8¼	13½	14	14½	7⅛	7½	7⅞
1″ to 1⅞″	18⅝	19	19⅜	6¼	6½	6¾	2¼	2½	2¾	7⅝	7⅞	8⅛	13⅝	14⅛	14⅝	7⅛	7⅜	7⅝
2″ to 2⅞″	18¾	19⅛	19½	6¼	6½	6¾	2⅜	2⅝	2⅞	7⅝	7⅞	8⅛	13¾	14¼	14¾	7⅛	7½	7⅞
3″ to 3⅞″	19	19⅜	19½	6¼	6½	6¾	2½	2⅝	2⅞	7½	7¾	8	13⅞	14⅜	14⅞	7⅛	7½	7⅞
4″ to 4⅞″	19⅛	19½	19⅞	6¼	6½	6¾	2½	2¾	3	7½	7¾	8	14	14½	15	7⅛	7½	7⅞
5″ to 5⅞″	19⅜	19¾	20⅛	6¼	6½	6¾	2½	2¾	3	7⅞	7⅞	7⅞	14⅛	14⅝	15⅛	7⅛	7½	7⅞
6″ to 6⅞″	19½	19⅞	20¼	6¼	6½	6¾	2⅝	2⅞	3⅛	7⅞	7⅞	7⅞	14¼	14¾	15¼	7⅛	7½	7⅞
7″ to 7⅞″	19¾	20¼	20½	6¼	6½	6¾	2⅝	2⅞	3⅛	7¼	7½	7¾	14⅜	14⅞	15⅜	7⅛	7⅜	7⅝
8″	19⅞	20¼	20⅝	6¼	6½	6¾	2¾	3	3¼	7¼	7½	7¾	14½	15	15½	7⅛	7½	7⅞
Tolerance	±⅜″			±¼″			±¼″			±¼″			±½″			±¼″		

TABLE I (Cont'd)

Ideal Proportions for Women

Upper Thigh			Lower Thigh			Calf			Ankle			Upper Arm			Lower Arm		
Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.
20½	21¼	22	13	13¾	14½	11¼	12¼	12¾	7⅜	7¾	8⅛	9⅞	10½	11⅛	8¼	8¾	9¼
20½	21¼	22	13	13¾	14½	11¼	12¼	12¾	7⅜	7¾	8⅛	9⅞	10½	11⅛	8¼	8¾	9¼
20⅝	21⅜	22⅛	13⅛	13⅞	14⅝	11⅜	12⅜	12⅞	7⅜	7¾	8⅛	9⅞	10½	11⅛	8¼	8¾	9¼
20⅝	21⅜	22⅛	13⅛	13⅞	14⅝	11⅜	12⅜	12⅞	7½	7⅞	8¼	9⅞	10½	11⅛	8¼	8¾	9¼
20¾	21½	22¼	13¼	14	14¾	12	12½	13	7½	7⅞	8¼	9⅞	10½	11⅛	8¼	8¾	9¼
20¾	21½	22¼	13¼	14	14¾	12	12½	13	7½	7⅞	8¼	9⅞	10½	11⅛	8¼	8¾	9¼
20⅞	21⅝	22⅜	13⅜	14⅛	14⅞	12⅛	12⅝	13⅛	7½	7⅞	8¼	9⅞	10½	11⅛	8¼	8¾	9¼
20⅞	21⅝	22⅜	13⅜	14⅛	14⅞	12⅛	12⅝	13⅛	7⅝	8	8⅜	9⅞	10½	11⅛	8¼	8¾	9¼
21	21¾	22½	13½	14¼	15	12¼	12¾	13¼	7⅝	8	8⅜	9⅞	10½	11⅛	8¼	8¾	9¼
21	21¾	22½	13½	14¼	15	12¼	12¾	13¼	7⅝	8	8⅜	9⅞	10½	11⅛	8¼	8¾	9¼
21⅛	21⅞	22⅝	13⅝	14⅜	15⅛	12⅜	12⅞	13⅜	7⅝	8	8⅜	9⅞	10½	11⅛	8¼	8¾	9¼
21⅛	21⅞	22⅝	13⅝	14⅜	15⅛	12⅜	12⅞	13⅜	7¾	8⅛	8½	9⅞	10½	11⅛	8¼	8¾	9¼
21¼	22	22¾	13¾	14½	15¼	12½	13	13½	7¾	8⅛	8½	9⅞	10½	11⅛	8¼	8¾	9¼
21¼	22	22¾	13¾	14½	15¼	12½	13	13½	7¾	8⅛	8½	9⅞	10½	11⅛	8¼	8¾	9¼
21⅜	22⅛	22⅞	13⅞	14⅝	15⅜	12⅝	13⅛	13⅝	7¾	8⅛	8½	9⅞	10½	11⅛	8¼	8¾	9¼
21⅜	22⅛	22⅞	13⅞	14⅝	15⅜	12⅝	13⅛	13⅝	7⅞	8¼	8⅝	9⅞	10½	11⅛	8¼	8¾	9¼
21½	22¼	23	14	14¾	15½	12¼	13¼	13¾	7⅞	8¼	8⅝	9⅞	10½	11⅛	8¼	8¾	9¼
±¼″			±¾″			±½″			±⅜″			±⅝″			±½″		

Taper Tolerances

Lower Thigh Calf			Calf-Ankle			Upper-Lower Arm		
Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.	Max.
1¼	1½	1¾	4¼	4½	4¾	1½	1¾	2
1¼	1½	1¾	4¼	4½	4¾	1½	1¾	2
1¼	1½	1¾	4⅜	4⅝	4⅞	1½	1¾	2
1¼	1½	1¾	4⅜	4⅝	4⅞	1½	1¾	2
1¼	1½	1¾	4½	4¾	5	1½	1¾	2
1¼	1½	1¾	4½	4¾	5	1½	1¾	2
1¼	1½	1¾	4⅝	4⅞	5⅛	1½	1¾	2
1¼	1½	1¾	4⅝	4⅞	5⅛	1½	1¾	2
1¼	1½	1¾	4¾	5	5¼	1½	1¾	2
±¼″			±⅛″			±¼″		

Explanation

The ideal proportion chart gives the average, minimum, and maximum measurements for women's figures. The limits take into account variations in bone structure. Obviously a heavy bone structure is compatible with measurements above the average and a light bone structure, below.

The leg measurements of a woman with long legs in proportion to height should be above the mean; of a woman with proportionately short legs, below the mean.

The taper chart gives limits which tend to insure pleasing proportions. The larger circumference precedes in the column headings. To obtain, the taper for a particular case—for example the calf-ankle: subtract the ankle from the calf measurement. The difference should fall within the taper limits. Continuing with the example, this guards against such possibility as having the calf on the lower limit of the ideal and the ankle on the upper with a consequent poorly shaped (too straight) leg, or other combinations which are equally undesirable.

Remember the accuracy of measurement does not usually exceed ⅛″.

vary with the height. For example, in the case of the upper thigh, it is $\pm\frac{3}{4}''$ whether the individual was 5′ or 5′8″ tall. Possibly a more accurate determination with more cases might lead to a wider bracket at 5′8″ than at 5′. In other words, it might be true that the tolerance should be correlated with the height.

Sufficient data have not been taken to demonstrate whether this is so or not. The differences involved are so small in comparison with the circumferences being measured that they are in the order of the accuracy of the measurements themselves. It is felt that, while the question is of theoretical interest, it is of no real practical importance.

Comparison with Willoughby's Work.—The work of Willoughby in this field has already been mentioned. The following figures for a corrected ankle girth of 8″ (near the average value) abstracted from his article are compared with ideals obtained by the present technique:

	Willoughby	Bowman-Wilson
Girth of neck	12.6	12.4
Upper arm	10.9	10.5
Girth of forearm	9.3	8.75
Girth of chest (normal)	32.5	32.8
Girth of waist	25.4	25.6
Girth of hips	36.35	36.
Girth of thigh	21.3	21.4
Girth of calf	13.25	13.25
Corrected ankle girth	8	

In most cases his ideals are well within the tolerance bracket. In a few they are on the upper limit. Remembering that the accuracy of measurement is within about $\frac{1}{8}''$, it is felt that, with the exception of the forearm, the agreement is surprisingly good, particularly since the methods of determining the ideals differed so greatly.

In the instance of maximum difference, this ideal is on the upper limit of our tolerance bracket. It happens that in our data a number of the original measurements fell at about $9\frac{1}{4}''$. All of these, without exception, tended to decrease in circumference with exercise and increase in strength. This trend leads us to place the average somewhat lower than is shown by Willoughby.

CERTAIN PRACTICAL PROBLEMS IN USING THE IDEALS

In using these ideals, consideration must be given to the relative proportion of the segments of the body to each other, and to the structure as a whole.

The idea of "taper" takes care of this. For example, if the ankle is brought to a measurement below the mean of the tolerance bracket for the individual, the calf should also be on the lower side. The difference between these two measurements should fall within the taper limits. Further, a heavy-boned girl to be in proportion should have

measurements above the average; a woman with a light skeletal structure, below the average. The taper is approximately the same. A very long leg in proportion to the height should have a taper near the higher limit. In applying these rules, always remember the accuracy of measuring probably cannot consistently be better than $\frac{1}{8}$" inch.

In checking a woman, it is usually found that a few measurements (most frequently the hip) miss the desired values by the greatest amount. Concentration of exercise initially on these will result in good proportions being approached much earlier. In our experience, an even distribution of subcutaneous fat over the body even though all of the measurements are high gives a better appearance than excess flesh all in one area. This is the importance of proper taper. Once such a condition is reached, then the effort can be directed toward an even decrease to attain the ideals.

It is interesting to note that decreases of 3 to 4 inches in all the trunk circumferences and 2 to 3 inches on the thighs have been recorded with substantially no variation in body weight.

In using the ideals, individuals are encountered where the massiveness of structure of the upper part of the body obviously indicates the upper limits should be used, and where the thighs and the legs are relatively light—or the reverse. The objectives of the program are weighted in accordance with the basic conformation of the segments. Particular attention must be directed however to the hip and abdomen measurements in such cases. Since they lie between the two sections with opposite tendencies they must be in scale with both. This definitely requires that they not be over their ideal dimensions, and preferably should be toward the lower side of the tolerance bracket.

The Survey in the Development of a Community Recreation Program

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THE term community has been variously defined. Popularly, and for purposes of this paper, a community refers to a unit of groups of various kinds, such as religious, educational, trade, and social. The community is centralized in organization and has a great variety of group relationships. Thus, a city, town, village, or hamlet is interpreted as a community.

The survey attempts to obtain factual information about existing conditions. It provides bases for (1) evaluation of existing practices, and (2) formulation of recommendations designed to improve the *status quo*. Hjelte has indicated other uses, such as an exhaustive compilation of relevant subject matter as a reference guide for technical students or less thorough compilations for guides for the administrator.[1] At the outset, then, it is important to ask the question, "What shall be surveyed and why?" A comprehensive survey is a means to an end and should be followed by concentrated action supported by community interest in an effort to effect changes as indicated by recommendations based on the gathered scientific information. Therefore, through the recreation survey, the public should be informed about developments and limitations of community recreation. This information must be accurate, up-to-date, and provide a factual basis as a starting point for cooperative planning for an improved recreation program.

The survey is not regarded by most scientists as research. However, it has a field of particular usefulness in that it answers practical questions. Carefully planned surveys which are reasonably extensive, relatively formal, and penetrating in their analyses may be classified as "research," opinions of scientists to the contrary.

SURVEY METHODS AND DATA-COLLECTING INSTRUMENTS

Various methods and devices or data-collecting instruments are employed in the recreation survey. The historical method is used to produce a record of the development of factors, such as finance, facilities, leadership, and administration. Documentary sources include records, reports, and other printed materials. Questionnaires, interviews, and observations are useful in obtaining information, such as recreative interests of groups of various ages, sex, and socio-economic status, and

A paper presented at the National Convention of the American Association for Health, Physical Education, and Recreation, Chicago, April 25, 1940.

[1] George Hjelte, "Research in Recreation," Res. Quart., 10:1 (March 1939) 3.

the manner and extent to which agencies are participating in community recreation. Photographs and moving and sound pictures may be used to depict limitations in facilities as well as outstanding features of programs. Functions of staff members are obtained through job analyses. Statistical techniques are used to manipulate data and determine relationships. Philosophical techniques are employed in interpreting data and formulating recommendations.

ENLISTMENT OF PUBLIC SUPPORT

Preparatory to the survey, some enthusiasm in favor of it must be exercised by a few influential persons in the community and a general approval of the survey idea should be expressed by many people. The newspapers, radios, churches, schools, and service organizations within the community are effective media for development of community interest. The crystallization of public sentiment in approval of the survey thus becomes one of the first objectives of a recreation survey.

SURVEY PERSONNEL

The sponsorship of the survey may be an established unit, such as the recreation council, park board, board of education, city council, council of social agencies, or a club. The survey group should be representative of the citizens. An alert and thoughtful group is familiar, at least to some degree, with the backgrounds, interests, and needs of the people, and the limitations of the *status quo*. Their cooperation in the survey would be a truly recreative and educational experience in community service. Furthermore, their active participation would enhance the chances for the practical application of recommendations. Finally, a survey group composed almost entirely of local citizens would tend to avoid what would appear to some to be domination from without. An advisory committee composed of representatives of public, semi-public, and private agencies avoids the feeling of domination on the part of some individuals, increases the cooperation of groups within the community, and expedites acceptance of recommendations for improvement.

Should a survey specialist or technician be employed to direct the survey? The specialist would render technical service which might not be available within the community, and he would view conditions more objectively than local people. However, he is likely not to understand the local scene as the residents do. Whether or not a specialist is employed, members of the community should participate in the survey.

THE SURVEY BUDGET

Following the appointment of a survey director and the formation of the survey group, the budget is prepared. The amount of money available will determine to a considerable extent the scope of the survey (the nature and amount of information to be gathered and the methods of obtaining it), the size of the survey staff, and the character of the report. One of the first duties of the survey director is to prepare, sub-

mit for approval, and obtain adoption of a budget which would include such items as salaries, equipment and supplies, office rent, transportation and communication, and printing or publication of the final report. The amount of the budget items may be reduced through cooperation of one or more agencies.[2] Provision for recreation opportunities is a function of municipal government, closely related to, and in the same sense as, the functions of protection of the lives and property of the people. Where there are no legal obstacles, local authorities should consider the use of tax funds for a community recreation survey a wise expenditure.[3]

SURVEY AREA

Obviously, preliminary to the survey the geographical boundaries of the area which defines the community most satisfactorily must be determined. The boundaries of the community area should be plotted tentatively on the best map obtainable. Brunner has suggested the addition of a half-mile on every side beyond the area tentatively plotted to insure that no territory is overlooked that ought to be surveyed.[4]

SCOPE OF SURVEY

What should the survey include? A study of the existing facilities is an important phase of a recreation survey. Effective planning will depend upon an understanding of the number and location of public buildings which are used for general community purposes, present and possible uses of such buildings, and problems involved.

Similar information should be obtained relative to public outdoor space for recreation: its location, how it is equipped, present and possible uses, and the problems involved in improving the use of the available areas. The survey includes the location, number of holes, and fees of public and private golf courses; the location, kind, fees, and number of public and private tennis courts; indoor and outdoor pools, beaches, availability of instruction and life guards; ice skating and other winter sports areas; topography of the community and its immediate vicinity.

Study of the commercial recreation facilities would include the number of theaters, seating capacities, admission charges, and average daily attendance of minors and adults for each; the number of licensed billiard halls and bowling alleys; number of public dance halls, frequency of dances, and average attendance.

The recreational desires of the people according to age, sex, socio-economic classification, nationality, and opportunities for their expression should be an object of study. One should not consider the par-

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[2] Recreation Council of Monongalia County, Lloyd M. Jones, Chairman, "A Survey of Recreation Opportunities and Problems in Monongalia County, West Virginia," (Mimeographed, Morgantown, W.Va., 1938) Preface.

[3] M. M. Chambers and Howard M. Bell, *How to Make a Community Youth Survey*. American Council on Education Studies, Series IV. American Youth Commission, Vol. III, No. 2. (Washington, D.C.: American Council on Education, 1939) 5–7.

[4] Edmund De S. Brunner, *Surveying Your Community* (New York: George H. Doran Company, 1925) 23.

ticipation of individuals or their verbal or written indications as a final or literal expression of recreational desires. Interests are dependent upon satisfying experiences, opportunities for which may or may not have been available. Thus, an evaluation of the program is a phase of the survey.

The survey of community organizations for leisure would include for each organization the name of the leader, places and number of meetings per month, number and age group of members, kinds and frequency of recreative activities sponsored, and the age groups served. The organizations can be classified as educational, youth serving, civic, athletic, musical, social, fraternal, patriotic, and social-religious.

If a community recreation program is already under way, the survey should include a comparison of the amount of tax funds appropriated for recreation with appropriations for other governmental functions, including per capita expenditures. The taxable wealth and tax rates should be scrutinized. Authorities are generally agreed that public support for recreation depends upon a public consciousness and appreciation of the value of the program to individuals as well as the community as a whole. Thus, adequate support will involve appreciations of the value of the program on the part of store clerks, day laborers, and others in the lower socio-economic groups as well as bankers, professional men, and other so-called community leaders. The sources of private and public money available for recreation together with a history of such appropriations should be included.

Statutes which pertain to recreation should be consulted before recommendations are made. An exhaustive survey may indicate need for recreation legislation in some localities.

THE SURVEY REPORT

The report to the public should be simple and clear so that it will be meaningful and understandable to those who read it. Conformity to the following criteria for research reporting is suggested: (1) unusual terms or those not readily understood by the layman should be defined; (2) sources and methods of collecting data should be indicated; (3) references, footnotes, and the mechanical details of tables, charts, and footnotes should be uniform; (4) the report should be organized for clarity and unity.

The use of spot maps, properly constructed graphs, line and bar charts as substitutes for statistical tables provides the reader with a pictorial presentation likely to produce the correct impression.

The Chicago Recreation Survey has utilized various means of pictorial presentation. Line and bar graphs are used effectively to show historically the assessed valuation of taxable property, total taxes collectable, and the growth of parks and playgrounds. A figure indicates the historical development of population per acre of parks. Spot maps,

accompanied by scales and keys, depict to advantage schools, supervised school and public playgrounds, congested and sparse population areas, population by age groups, public and private golf courses, tennis courts, swimming pools, beaches, lagoons, harbors, property controlled by tax supported recreation and education agencies, bridle paths, museums, library facilities, licensed bowling alleys, and billiard halls.[5]

Scientific standards for the evaluation of community recreation are not available. Suggested standards for cities of 50,000 or more may be obtained from the National Recreation Association.[6] They have been adapted and used to appraise comparable districts in Los Angeles[7] and also used as a starting point in the preparation of score cards which have been employed in other localities.[8] Lacking accepted *scientific* standards, recommendations for improvement should be based temporarily upon expert agreement, accepted standards, and comparisons between comparable communities and data.

The report should be edited carefully before it is published and should include name of author, acknowledgements, place of publication, date, where it may be obtained, and the cost.

The recreation survey actually is never completed. It should be a continuous process in an effort to obtain facts useful in making decisions which will improve programs.

CRITERIA FOR A COMPREHENSIVE RECREATION SURVEY

The following are submitted in summary as ten criteria of a comprehensive community recreation survey:

1. The survey group should be representative of the citizens.
2. A survey technician or specialist should be employed if the community lacks competent direction.
3. A budget should be prepared.
4. The survey should be planned carefully.
5. Research techniques should be employed to gather factual information.
6. The survey should reveal a complete picture of the existing conditions.
7. The report to the public should be attractive, organized, simple, and clear so that it is meaningful and understandable to those who read it.
8. Prejudices should be avoided.
9. The report should be an incentive to improve the *status quo*.
10. The survey should be a continuous process.

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[5] *Chicago Recreation Survey*, Vol. I *Public Recreation*, 1937, p. 268; Vol. II *Commercial Recreation*, 1938, p. 167. (Chicago: Clarke-McElroy Publishing Company).

[6] National Recreation Association, *Schedule for the Appraisal of Community Recreation*, (Mimeographed) M.P. No. 167. (New York: National Recreation Association).

[7] George Hjelte, *op. cit.*, 5–6.

[8] William R. LaPorte, Chairman, Committee on Curriculum Research, Report of Subcommittee II, "Selection and Adaptation of Activities." *Procedings, The College Physical Education Association*, p. 162–65.

Learning Problems in Student Teaching

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IN ACCORDANCE with good principles of teacher education, certain prerequisites are necessary for student teaching in physical education in public schools. These include satisfactory achievement in academic and professional studies, mastery of physical education skills, knowledge of special methods, the integration of educational theory and practice through demonstration teaching, observation and participation, and certain personality qualifications. The question, however, arises as to whether this background is an adequate orientation to student teaching in public schools. What learning problems does the student teacher actually encounter? Is the student prepared to deal with these? Do the best textbooks on methods of teaching physical education consider the difficulties reported by student teachers?

This study represents findings that are in part an answer to the above questions. The information thus obtained is from a local situation, it is true, but it should be adaptable, in whole or in part, to other situations. It is realized, too, that the criteria are empirically established, but this procedure seems justifiable in view of the nature of this particular problem.

THE PRESENT STUDY

The purpose of this study was:

1. To find out the learning problems encountered by student teachers in public schools.

2. To discover the amount of attention given to the reported problems by two authoritative textbooks on methods of teaching physical education.

3. To secure data which might give some direction to teacher education.

During the winter season, thirty students in the senior year at a teachers college of physical education were assigned for student teaching in public schools for a period of nine weeks. They spent all their time at the schools but reported to the College for general conferences on Saturday mornings. Each week the students brought ten problems which had affected their pupils' progress in learning. The most general topics were discussed at the conference.

At the end of the student teaching session, all problems were reread, and if a student mentioned a difficulty more than once, duplicates

were eliminated. The remaining 882 problems were then tallied and classified under accepted divisions of methods of teaching, such as

TABLE I

DISTRIBUTION OF 882 LEARNING PROBLEMS REPORTED BY 30 STUDENT TEACHERS IN PHYSICAL EDUCATION

Problems in Student Teaching	Number	Per Cent
Facilities and equipment	177	20.07
Special methods	173	19.61
Management	158	17.91
Class organization	100	11.34
Attitudes of pupils	76	8.62
Classification and individual differences	73	8.28
General method	59	6.69
Curriculum	41	4.65
Student teacher	25	2.83

TABLE II

DISTRIBUTION OF 177 PROBLEMS OF INADEQUATE FACILITIES AND EQUIPMENT REPORTED BY 30 STUDENT TEACHERS IN PHYSICAL EDUCATION

Nature of Student Teaching Problem	Times Mentioned		Per Cent
Gymnasium	97		54.80
Bad light, heat, and ventilation		18	
Pipes in gymnasium leak		12	
Dirty gymnasium		11	
Used as an auditorium and cafeteria		9	
Small gymnasium		9	
Boundary lines are not marked		8	
Dangerous obstacles in gymnasium		8	
Used at same time by boys and girls		6	
Basement gymnasium		5	
Poor acoustics		5	
Floor slippery, uneven, or broken		4	
Separate building		2	
Equipment and supplies	40		22.60
Inadequate, dirty, or broken		17	
No blackboard or bulletin board		6	
Music not provided for teaching rhythm		5	
Mats stiff with paint or dirty		3	
Pupils' projects prevent use of classroom for physical education		3	
No clock in gymnasium		2	
No baskets for teaching basketball		2	
No demonstration platform		1	
No storage space for equipment		1	
Locker room	32		18.08
Inadequate space		15	
No showers		12	
No towels		3	
Poorly ventilated and heated		2	
Playground	8		24.5
No playground		5	
Playground is not surfaced		2	
Too far from school		1	

facilities and equipment, class organization and management, general method, special method, curriculum, classification and individual differences, attitudes of pupils and the student teacher.

Then two of the best textbooks on methods of teaching physical education were examined, and the percentage of pages allocated to each of the above classifications was determined.

TABLE III

NATURE OF 173 LEARNING PROBLEMS IN SPECIAL METHOD REPORTED BY 30 STUDENT TEACHERS IN PHYSICAL EDUCATION

Problem in Special Method	Times Mentioned		Per Cent
Methods of teaching basketball	38		21.96
How to teach technique of passing, pivot, shooting, offense, and defense		21	
How to cultivate interest in fundamentals and lead-up games		8	
How to teach rules		5	
Children do not move around		3	
How to overcome bad techniques learned out of school		1	
Methods of teaching games	24		13.87
Respect for referees' decision		4	
How to teach obedience to rules		3	
Children push, shove, and monopolize games		3	
Children go over line in relay races		3	
Application of skills in game form		4	
Children try to be "it" in tag games		2	
Children won't admit when "out"		1	
Pupils do not want to learn new games		1	
How to give "tag" lightly		1	
Teacher has to play with little children		1	
How to find key for singing game		1	
Methods of teaching marching	21		12.13
Technique of marching		9	
Rhythm and step		8	
Patterns		3	
Spacing		1	
Methods of teaching social dancing	13		7.51
Getting pupils on floor		2	
Learning steps		3	
Taking partners		8	
Methods of teaching order exercises	11		6.35
Fall in		2	
Facing		7	
Dressing		2	
Methods of teaching rhythm	10		5.78
Methods of teaching volleyball	10		5.78
One-hand tap		5	
Technique of serving		3	
Positions and rotation		2	
Methods of teaching folk dancing technique, rhythm, formation	9		5.20
Methods of teaching gymnastics, tumbling, and stunts	9		5.20
Methods of teaching team play	8		4.63
Methods of teaching soccer, badminton, bowling, table tennis, boxing, high jump, running	8		4.63
Methods of teaching tap dancing	6		3.46
Methods of teaching formations	3		1.75
Methods of teaching swimming	3		1.75

FINDINGS OF THE STUDY

Table I shows the distribution of 882 learning problems which 30 student teachers in physical education encountered during student teaching in public schools. Inadequate facilities and equipment account for the largest number of problems. Next in order come issues of special method, management, class organization, pupils' attitudes, classification and individual differences, general method, curriculum, and personal problems of the student teacher.

Table II indicates that 177, or 20.07 per cent, of the learning problems are concerned with defective and poorly maintained facilities and equipment. Of these, 138 are caused by poorly constructed and unsanitary gymnasia and locker rooms.

Problems of special method which appear in Table III come second. These were mentioned 173 times and constitute 19.61 per cent. Technical issues in teaching basketball were highest. Other difficulties mentioned by student teachers are distributed over a variety of physical education activities.

Table IV shows that questions of management account for 158 or

TABLE IV

NATURE OF 158 PROBLEMS IN MANAGEMENT REPORTED BY 30 STUDENT TEACHERS IN PHYSICAL EDUCATION

Problem	Times Mentioned		Per Cent
Discipline and order	55		34.80
How to discipline and control class		23	
Boys chew gum		9	
Inefficient method of roll call creates disorder		7	
Pupils will not remove sweaters or ties for class		6	
Boys throw lunch papers on floor, spit on floor, drag mats		4	
Costumes are dirty or torn		3	
Athletes loaf in gymnasium and cause disturbance		3	
Excuses	48		30.35
Pupils get excused or cut gymnasium classes		20	
Pupils waste time dressing or come late		23	
Many excuses given for colds, infectious diseases		5	
Supervision of locker room	28		17.71
Disorderly and untidy locker room habits		9	
Fooling in locker room		8	
Pupils won't take showers		4	
How to supervise locker room and swimming pool		4	
Locks difficult to open, pupils forget numbers		2	
Pupils neglect to dry hair after shower		1	
Safety	22		13.91
Dangerous obstacles in gymnasium, broken floors or equipment, accidents, matches		16	
Pupils wearing glasses take part		4	
Boys are permitted to work in street shoes		2	
Pupils have too much or not enough freedom	3		1.97
The best division of class time	1		.63
When to use a whistle	1		.63

17.91 per cent of all learning problems. Of these, 55 refer to matters of discipline, 48 to excuses from class, while issues of safety and locker room supervision make up the balance.

Learning problems caused by deficiencies in organization are listed in Table V. It might be noted that every student teacher mentioned two major handicaps to pupil learning: (1) pupils do not have gymnasium suits and shoes, (2) classroom activities take precedence. Extremely large classes were reported by 50 per cent of the student teachers.

TABLE V
DISTRIBUTION OF 100 PROBLEMS IN ORGANIZATION ENCOUNTERED IN STUDENT TEACHING

Nature of Learning Problem	Times Mentioned	Per Cent
Pupils cannot afford or neglect to bring gymnasium suit and shoes	30	30.00
Classroom teachers get pupils excused as their activities take precedence	30	30.00
Very large classes in high school	15	15.00
Time scheduled for health and physical education insufficient	8	8.00
Gymnasium classes interrupted by unscheduled teachers' meeting, assembly, notices, medical examinations, lunch hour program, carpenters, or pupils sent to be disciplined by teacher of physical education	5	5.00
Only one bell rung to change classes	4	4.00
Teacher of physical education allowed no time for administrative duties	3	3.00
Period too long for elementary school	2	2.00
No time scheduled for showers	2	2.00
No room assigned for teaching health	1	1.00

Problems related to pupil attitudes are mentioned 76 times, classification and individual differences 73 times, with those of general method and curriculum next in order. Personal issues in the adjustment of student teacher rank last. These are all summarized in Table VI.

Table VII presents the per cent of pages of two textbooks on methods of teaching physical education activities which deal with the learning problems encountered in student teaching. In the field of facilities and equipment where student teachers find most problems, textbook *A* has the least material and textbook *B* none at all. Both texts emphasize considerations of general method where students submit fewer problems. Textbook *A* uses 34.47 per cent of pages for special method and textbook *B*, 7.36 per cent. Student teachers reported 19.61 per cent of all their problems in this field. Student teachers' problems of organization and management total 29.25 per cent of the 882 mentioned. Textbooks *A* and *B* give respectively 26.40 and 9.47 per cent of space to these issues.

TABLE VI

CLASSIFICATION OF 274 ADDITIONAL LEARNING PROBLEMS REPORTED BY 30 STUDENT TEACHERS IN PHYSICAL EDUCATION

Classification of Problem	Times Mentioned		Per Cent
Attitudes of pupils	76		27.74
Noisy, restless, unruly pupils		27	
How to teach fair play and honesty, cooperation, responsibility, good sportsmanship		16	
Children talk too much		8	
Children tattle on each other		6	
Stealing in the locker room		4	
Tired and sleepy children		4	
Child won't play with other children, tease each other, won't take turns		4	
How to overcome rough play		3	
Profanity		2	
Boys hate class in character education		1	
Children answer back		1	
Classification and individual differences	73		26.64
No classification for physique, ability, grade, or sex		19	
Slow learning rate of children with poor mental ability		10	
Arguments between white and colored children		9	
Adolescent boys and girls are silly in corecreation		8	
Crippled, deformed, or cardiac cases in regular class		8	
Overage or overweight children in lower grade		7	
The problem child in class		4	
Athletes are given special privileges		3	
Different social classes do not mix		2	
Pupils have different rates of learning		2	
Lack of attention to individual differences		1	
General method	59		21.53
How to secure and maintain pupils' attention for discussion, demonstration, or explanation		23	
How to train student leaders and officials		11	
How to teach pupils to relax		6	
How to develop good posture		4	
Best method of awards, tests, and marks		4	
How to use discussion and questions		3	
How to teach class formations		2	
Adaption of method to both elementary and secondary school pupils		2	
Amount of drill to learn skills		1	
When to make corrections		1	
How to keep pupils quiet		1	
How to teach with victrola		1	
The curriculum	41		14.96
Pupils dislike dancing, basketball, swimming, marching, and gymnastics		12	
Pupils do not like physical education activities		10	
Program restricted to one activity		9	
Pupils cannot do high school work because of inadequate elementary school program		4	
Selection of graded materials		3	
Grade teachers won't teach physical education		1	
Too many out-of-school interests		1	
Religion won't permit dancing		1	

TABLE VI (Continued)

Classification of Problem	Times Mentioned	Per Cent
The student teacher	25	9.13
What to do with disrespectful pupils	3	
How to adapt voice to large space	5	
Difficulty in getting lesson completed	3	
Other teachers request services	3	
Skills and techniques different from regular teacher	3	
How to cut down talking and start class quickly	2	
Degree of authority and friendliness	2	
Uncertain schedule for teaching	1	
Impatience with slow pupil learning	1	
Classroom teacher talks during lesson	1	
Fear of offending regular teacher by using different materials	1	

TABLE VII

COMPARISON OF PER CENT OF 882 LEARNING PROBLEMS REPORTED BY 30 STUDENT TEACHERS AND PER CENT OF 2 TEXTBOOKS DEVOTED TO THESE TOPICS

Nature of Problems	Per Cent	Per Cent of Textbook *A*	Per Cent Textbook *B*
Facilities and equipment	20.07	3.48	0
Special methods	19.61	34.47	7.36
Management	17.91	9.47	26.40
Organization	11.34	(included with management)	(included with management)
Attitudes of pupils	8.62	(included with general method)	(included with general method
Classification and individual differences	8.28	(incidental in general method)	11.69
General method	6.69	38.64	55.67
Curriculum	4.65	12.91	1.04
Student teacher	2.83	1.14	0

CONCLUSIONS

The study reveals that 49.29 per cent of 882 learning problems reported by 30 student teachers relate to practical issues, such as inadequate facilities and equipment and difficulties in organization and management. Two standard textbooks of methods of teaching physical education give 12.95 per cent and 26.40 per cent of space respectively to these subjects.

Problems of special method come second. As these problems pertain to a large number of physical education activities, it is evident that the intricacies of teaching techniques constitute real obstacles to pupil learning. Textbook *A* gave 34.47 per cent, slightly more than one-third of its pages, to special methods and textbook *B* gave 7.36 per cent. The teachers college might provide student teachers with more experi-

ence in analyzing physical education skills and in developing applicable teaching techniques.

Only 28.24 per cent of all problems relate to considerations of the curriculum, classification and individual differences, general method, and pupils' attitudes. The authorities on methods of teaching physical education devote 52.69 per cent and 68.40 per cent of their textbooks respectively to just these topics. It may be that the student teachers did not identify many of these problems because they had been so well oriented to student teaching. On the other hand, practical issues of facilities, equipment, organization, and management may have loomed large enough to exclude the more theoretical considerations of general method.

Personal difficulties of the student teachers are mentioned 25 times and constitute only 2.83 per cent. It is possible that these 30 students were effectively inducted into student teaching, or that in considering the pupils' learning problems, they neglected to mention their own. Textbooks have very little on this subject, 1.14 and 0 per cent, respectively.

Achievement Tests in Volleyball for Junior High School Girls

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VOLLEYBALL is a game well suited to the junior high school level and will undoubtedly continue to hold an important position in the junior high school girls' physical education program. When the available literature was studied for volleyball tests, very little was to be found for the seventh, eighth, and ninth grades. The authors decided therefore to set up certain criteria, study high school and college tests, and with these criteria in mind choose those which seemed best suited to the junior high school situation. The chosen tests were tried out and modified slightly. Their reliability and validity were studied and achievement scales were made from the data collected. This paper presents the methods, results, and conclusions of these studies.

PROBLEM I—SELECTION OF THE TESTS

In choosing tests, the writers had the following questions in mind:

1. Does the test have acceptable reliability?
2. Does the test have acceptable validity?
3. Is the test objective?
4. Is it easy to administer?
5. Does it diagnose pupil weakness?
6. Does it measure pupil progress?
7. Is it a device for teaching as well as testing?

Since volleyball as played in the junior high school is a fairly simple game, all tests for the spike or kill were automatically eliminated. A survey of the remaining tests of any acceptable reliability and validity[1]* revealed that, with the exception of those of French and Cooper,[2] the tests either required too much equipment and time to administer or failed to discriminate between fair and above average ability. French and Cooper included four tests in their study: (1) repeated volleys, (2) serving test, (3) set-up and pass, (4) recovery from net. These tests were tried out on a small group of students. It was decided to eliminate tests 3 and 4. They lack objectivity, since they involve a

* Numbers refer to references in Bibliography at end of article.

player other than the one tested. They also have lower reliability coefficients and add little to the validity of the battery. Both French and Cooper and Glassow and Broer agree that the combination of tests 1 and 2 is a *reliable* battery for grades nine to twelve. This combination, therefore, was studied for grades seven, eight, and nine.

During a three-month period these tests were administered to students as part of the regular class work. Certain modifications were made early in the trial and then the data collected were used for the reliability study. The modifications were:

1. The *repeated volleys* was changed to three trials of 30 seconds each, thus reducing the testing time by one minute.

2. The *serving test* was changed to two trials of the sum of ten serves. The increase in time resulting was partly compensated for by the reduction in time in the repeated volleys.

A full description of the tests is to be found in the Appendix.

PROBLEM II—RELIABILITY

The subjects for the reliability study were seventh, eighth, and ninth-grade girls in regular physical education classes. All of the testing was supervised by Miss Russell. Each test was administered twice to the same girl. The time interval between the two sets of scores for each test was constant—five days. Since the number of class periods which could be devoted to testing was limited, it was impossible to use the same group of girls for both the repeated volleys and the serving test. Consequently data were not obtained for the reliability of the battery. The coefficient of reliability given is the product-moment correlation coefficient between the first and second set of scores of each test.

TABLE I
COEFFICIENTS OF RELIABILITY

Tests	N	r
Best of three trials of repeated volleys	70	.870
Sum of three trials of repeated volleys	69	.901
Best of two trials, serving test	53	.915
Sum of two trials, serving test	52	.900

These are all acceptable reliabilities. It was gratifying to find that the reliability coefficients for the "best" were very close to those for the "sum." It seems safe to assume that if the components of a battery are reliable, the battery will be reliable.

PROBLEM III—VALIDITY

The validity study divides itself into three parts:

A. Subjective rating of the players by seven judges.

B. Rank order rating of the players by the best qualified judge.

C. Multiple correlation coefficients between criteria and the test battery, and multiple regression equations.

A. Subjective Rating of Players by Several Judges.—The subjects of the validity study were sixty-six members of a volleyball club which met one school period a week during the spring of 1939 at Marina Junior High School. They were from all grades of the school and were divided into teams roughly according to grade. These teams played a continuous round-robin tournament throughout the semester. When the tournament was well under way, Miss Russell administered the two tests to the club members at noon or during the students' free activity period. Several weeks later these same girls were judged by seven judges —three physical education teachers and four cadet teachers, physical education majors, under the direction of Mrs. Florence Stephenson of the San Francisco State College. The judges watched the girls in action for five days and rated each girl on a four-point scale, 4 being excellent, 3 good, 2 fair, and 1 poor in playing ability. Since all judges rated every player, the sum of the judges' ratings was used as the subjective score of each player. To obtain a measure of validity the test scores of the players were correlated by the product-moment method with the subjective rating score. The results are found in Table II, column three.

TABLE II
COEFFICIENTS OF VALIDITY—SUM OF JUDGES' RATINGS

Test	N	r	$r_{\infty\infty}$	r_a
Best of three trials of repeated volleys	66	.670	.800	.738
Sum of three trials of repeated volleys	66	.673		
Best of two trials, serving test	66	.613	.677	.634
Sum of two trials, serving test	66	.620		
Battery of best of trials	66	.774		.824

By various statistical procedures the r's of column three may be raised. For example, in column four, two of the coefficients have been treated by the Spearman correction for attenuation (Garrett, p. 335 [3]). In column five are corrections based on the following formula suggested by Dr. C. H. McCloy.* This formula corrects for random errors in the criterion but not in the test itself.

$$r_a = \sqrt{\frac{r_{x_1y} \cdot r_{x_2y}}{r_{x_1x_2}}}$$

x_1 is the sum of the ratings of three of the best six judges, x_2 is the sum of the other three of the best six judges chosen at random, and y is the test score. Both types of correction minimize error on the part of the judges and strengthen the validity. $r_{x_1x_2}$ is a measure of the reliability of the judges. Its value was .818 which becomes .900 when the Spearman-Brown formula for estimating the reliability of a test from two comparable halves is applied (Garrett, p. 319).

The results listed in Table II, column three, are somewhat higher than those of French and Cooper for ninth-grade girls and certainly

* Personal communication.

substantiate their findings. The writers were gratified to obtain coefficients as high as these. They had felt while the judging was in progress that the time was very short for accurate judging of so many players.

B. Rank Order Rating of Players by Best Qualified Judge.—In the October, 1939, issue of the RESEARCH QUARTERLY appeared the study, "A Basketball Motor Ability Test for College Women and Secondary School Girls" by Dyer, Schurig, and Apgar. They obtained quite high validity coefficients for their component tests. One criterion used was the rank order rating of the players by one judge. This suggested the following procedure. Miss Russell, who knew the playing ability of the girls better than anyone and who had not studied their test scores or ratings for three months, made two rankings of them. In the first she ranked all sixty-six girls, as she remembered them, in order as to playing ability. In the second case she ranked only girls of the club whose relative playing ability was certain. This last group consisted of twenty-four girls and their rank is as accurate as the best judge can make it. These rank order ratings were then correlated with the "best" scores in each test and the total "best." (Since the results of Problem II and Problem III-A show little difference between the "sum" of the trials in the tests and the "best" of the trials, and since the "best" of the trials is a better psychological choice for the subjects of a test, the rest of the studies were limited to the "best".) The results of this study are listed in Table III. In column four, the coefficients of column three, Table II, are repeated for purposes of comparison. The rank difference method of correlation was used to obtain r (Garrett, p. 360 and Table 45).

TABLE III

CORRELATION OF TEST SCORES WITH RANK ORDER RATING OF BEST JUDGE

	Russell 66 r	Russell 24 r	Seven Judges 66 r
Best of three trials of repeated volleys	.61	.78	.67
Best of two trials, serving test	.60	.88	.61
Battery of best of trials	.72	.93	.77

A comparison of columns two and four suggests the conclusion that one judge thoroughly familiar with the players may be almost as good for subjective rating as several less familiar judges. A comparison of column three with both two and four would lead to the conclusion that probably an intensive study of a small number of players will give higher validity coefficients than an extensive study of many. The high correlation between the players whose rank order is certain and the tests trends to strengthen the feeling that the tests are valid measures of volleyball playing ability.

C. Multiple Correlation Coefficients between Criteria and the Test Battery, and Multiple Regression Equations.—To complete the study of

the two tests as a battery for testing volleyball playing ability, the multiple correlation coefficients and the multiple regression equations of the tests with two of the criteria were found. The Russell rating of twenty-four players was not included because it was felt that the number of cases was too small for accurate results. Table IV contains the primary data, the multiple *R's*, and the simplified regression equations. (The procedure used to obtain $R_{J(VS)}$ was that of Garrett, [pp. 415-419]). The o-order coefficients of $R_{R(VS)}$ were found by the rank-difference method. It is impossible to treat the rank of a player as a score and obtain a valid standard deviation. At the suggestion of Dr. C. H. McCloy*, the mean of the rankings was taken as 50 and the standard deviation as 16.67. $R_{R(VS)}$ was found by the method cited above but the regression equation was found by the short method (Garrett, pp. 427-428). It should be noted that the correlation between the serving test and repeated volleys is .410. This indicates that these tests do test different elements to a large extent.

TABLE IV

Key

V best of three trials, repeated volleys
S best of two trials, volleyball serve
J sum of ratings of seven judges
R rank in Russell rank order rating.

	N	*M*	σ	*r*	Multiple *R*	*Regression Equation*
V	66	29.0	9.84	*VS* .41	$R_{J(VS)}$ .770	$J = V + S$
S	66	21.6	8.19	*JV* .67		
J	66	16.4	4.51	*JS* .61		
R	66	50.0	16.67	*RV* .61		
				RS .60	$R_{R(VS)}$ .723	$R = V + S$

These results indicate that the best possible estimate of a player's ability in volleyball (as she would be judged by the judges in this study) will be obtained by simply adding her best score in the repeated volleys to her best score in the serve (Garrett, p. 450). Since the number of students in this study is so small, the writers hesitate to offer this as a standard for others to accept without verification. However, it is well worth further study. If these results are corroborated by other investigators it would seem to indicate a simple and objective method of estimating volleyball playing ability from skill tests.

CONCLUSIONS

From Problem I.—Two tests of French and Cooper (serving test and repeated volleys with slight modifications) should prove to be a good battery for use in junior high school girls' physical education.

From Problem II.—These tests are sufficiently reliable and the "best" of the trials is as reliable as the "sum."

* Personal communication.

From Problem III-A.—The validity of the tests based on a subjective rating of seven judges is about the same in the seventh, eighth, and ninth grades as in the ninth grade of French and Cooper's study. The validity of the battery is acceptable and the "best" is as valid as the "sum" of the trials.

From Problem III-B.—The rating of players by one judge thoroughly familiar with their playing may be nearly as accurate as the combined ratings of several judges. Since the highest correlations are found between the test scores and the most intensive rank order placement of twenty-four players by the best judge, the tests are probably valid. That is, the more accurate the subjective ratings, the higher the correlation.

From Problem III-C.—The subtests measure different skills of volleyball playing ability. The best estimate of a player's ability in volleyball obtainable from these tests is to be found by adding her "best" score in the repeated volleys to her "best" score in the serve.

PROBLEM IV—SCALING THE TESTS

During the year 1939 data for making scales were collected by Miss Bessie T. May of Buckingham Junior High, Springfield, Mass.; Miss Doreen Foote of the Avalon Junior High School, Avalon, Calif.; Miss Frances McCanse and Miss Asta Selchau of Santa Rosa High School, Santa Rosa, Calif.; and Mrs. Mary Jane Cameron and Miss Naomi Russell of Marina Junior High School, San Francisco, Calif. These data were combined and scales were made following the plan of Neilson and Cozens[5] (pp. 168-171). Since both distributions were skewed toward the lower scores, the Neilson and Cozens plan of correction was followed.

TABLE V
BASIC SCALE DATA

Test	N	M	Sigma	Increment Used	
				Above Mean	Below Mean
Best of three trials, repeated volleys	795	21.79	9.60	.576	.436
Best of two trials, serving test	506	16.32	9.63	.578	.326

Table V contains the means, sigmas, and increments used in making the scales which are appended to the article. The scale scores for each test were made on the basis of 100 points so that each test could be used without relation to the battery. If an approximate scale score for the battery is desired, add the score a girl makes in the repeated volleys to the score she makes in the serving test and divide by 2. For example, if a girl made a raw score of 22 in the repeated volleys and 16 in the serving test, her scale scores in the separate tests would be 50 and 49 respectively and her scale-score in the battery would be $(50 + 49) \div 2$ or 49.5.

APPENDIX

Repeated Volleys Test

Equipment.—Balls, stop watch, wall space, special court markings: (*a*) line 10′ long marked on the wall at net height, 7′ 6″ from floor; (*b*) line on the floor opposite the wall marking, 10′ long and 3′ from the wall.

Test.—The player being tested shall stand behind the 3-ft. line, and with an underhand movement shall toss the ball to the wall. When it returns she shall volley it repeatedly against the wall above the net line for 30 seconds. The ball may be set up as many times as desired or necessary; it may be caught and restarted with a toss as at the beginning. If the ball gets out of control, it must be recovered by the subject and brought back to the 3 ft. line to be started over again as at the beginning.

Score.—The score shall be the number of times the ball is clearly batted (not tossed) from the 3-ft. line on the floor to the wall above or on the net line.

Test Procedure.—Give each girl three trials. The trials should not follow each other immediately due to fatigue factor. The best score of the three trials is her test score. Consult the Achievement Table for point value of her test score.

Test Suggestions.—Test as many girls at one time as available wall space permits. All pupils can be trained easily to accurately score the test.

Serving Test

Equipment.—Regulation court, 30′ by 60′; regulation net, 7½′ in height; regulation balls.

Special court markings:

a) Chalk line across court 5′ inside and parallel to end line.

b) Chalk line across court parallel to net, 12½′ from center lines directly under net.

c) Chalk lines 5′ inside and parallel to each side line, extending from line under net to line (1).

d) Chalked numbers in center of each area to indicate its value.

(1) Area nearest net in center of court—value 1.

(2) Areas on either side of this area—value 2.

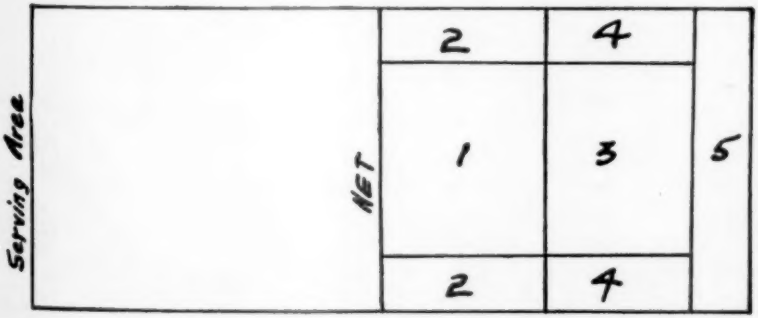
(3) Area directly behind area 1—value 3.

(4) Areas directly behind areas 2 and on either side of area 3—value 4.

(5) Entire end area farthest from net—value 5.

Test.—Player being tested stands behind the end line in the serving area and is given 10 serves into the target in court across the net. Any legal service is permitted. "Let" shall be served over.

Score.—Area Score—point value of spot on which served ball lands, as indicated in diagram. A ball landing on line separating two areas is scored the highest value. Ball landing on side or end lines scores value of area the line bounds. Serves



in which foot faults occur score zero. Trial Score—the sum of the 10 area scores for the trial. Test Score—the better of the two trial scores.

Test Procedure.—Give each girl 2 trials of 10 serves. Trial 1 and trial 2 should not follow one another immediately due to fatigue factor. Her test score is the better of the two trial scores. Consult the Achievement Table for point value of her test score.

VOLLEYBALL ACHIEVEMENT SCALES

Scale Score	Test Scores Serve	Repeated Volleys	Scale Score	Test Scores Serve	Repeated Volleys
100	..	51	50	..	22
99	45	50	49	16	..
98	44	..	48	..	21
97	..	49	47	..	..
96	43	..	46	15	20
95	..	48	45	..	..
94	42	..	44	..	19
93	41	47	43	14	..
92	..	46	42	..	..
91	40	..	41	..	18
90	..	45	40	13	..
89	39	..	39	..	17
88	..	44	38	..	..
87	38	43	37	12	16
86	37	..	36	..	..
85	..	42	35	..	15
84	36	..	34	11	..
83	..	41	33	..	..
82	35	..	32	..	14
81	..	40	31	10	..
80	34	39	30	..	13
79	33	..	29	..	..
78	..	38	28	9	12
77	32	..	27	..	..
76	..	37	26	..	..
75	31	36	25	8	11
74	30	..	24	..	..
73	..	35	23	..	10
72	29	..	22	7	..
71	..	34	21	..	9
70	28	..	20	..	..
69	..	33	19	6	8
68	27	32	18	..	..
67	26	..	17	..	..
66	..	31	16	5	7
65	25	..	15	..	..
64	..	30	14	..	6
63	24	..	13	4	..
62	23	29	12	..	5
61	..	28	11	..	..
60	22	..	10	3	4
59	..	27	9	..	..
58	21	..	8	..	..
57	..	26	7	2	3
56	20	25	6	..	..
55	19	..	5	..	2
54	..	24	4	1	..
53	18	..	3	..	1
52	..	23	2	..	..
51	17	..	1	..	..

Test Suggestions.—Two girls may be tested on each court by marking target on both sides of court and having one girl serve from each serving area. Scoring cards with spaces for the 10 area scores and trial score simplify the scoring for squad leaders.

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Psychological and Pedagogical Factors Involved in Motor Skill Performance as Exemplified in Bowling

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THIS study is an investigation of motor skills employed in bowling. It includes a study of the relationship of forms, habits, and techniques of bowlers to performance. The purpose of the study is to attempt to discover some of the psychological and pedagogical factors which affect, either favorably or unfavorably, the motor skill performance of bowlers; in brief, to try to show that while certain instructional methods and habits are important to the acquisition of skill, there are, nevertheless, certain psychological situations which may affect the mental reaction of the individual in such a way as to greatly hinder the attainment of higher limits of skill. The solution of this problem calls for a detailed investigation of facts relative to scores, psychological reactions, distractions, superstitions, forms and techniques, physical characteristics, recreational preferences, and common methods of instruction as described in manuals.

WHY THIS PROBLEM WAS SELECTED

This problem was selected because of the belief that intelligent research is needed in the various physical motor activities if improvement is to be made in the present-day methods of instruction. Methods in vogue now have been built almost wholly on empirical findings. Beginners in bowling for the most part have learned through imitation and by copying the styles of successful bowlers. Although instruction is being introduced into the school programs of physical education, it is as yet unsatisfactory because no approved methods of instruction have been developed. Even though teachers carefully follow the techniques of expert bowlers, they still have no patterns to follow for correcting faults or for adapting styles to individual differences.

Little scientific research has been conducted in the field of recreational sports; and none in the particular game of bowling. This will be the first extensive research study in which a large amount of data concerning this sport has been collected and investigated.

The game of bowling offers an objective approach to the advancement of scientific knowledge in physical education activities.

This paper is an abstract of a dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, University of Michigan, 1940.

Further incentive to study this problem was derived from the fact that bowling has made a wide appeal in recent years to people of all age levels. Bowling offers moderate exercise and opportunity for sociability that is afforded by few other sports. It is estimated that 15,000,000 people participated in bowling during 1940, 3,000,000 of whom were women bowlers. Thousands of high school boys and girls also use bowling as a form of physical exercise and for recreational diversion. The High School Bowling Club of Chicago alone has a membership of 14,000 boys and girls.[1] Detroit, in 1938, had about one-half as many bowling students as Chicago. Toledo, St. Louis, Cleveland, and Akron follow in order of number of players. In Los Angeles plans are being made to hold high school telegraphic tournaments with distant cities.[2]

QUESTIONS IT IS HOPED THIS INVESTIGATION WILL ANSWER

What is the relationship between instruction as described in bowling manuals and the forms and habits of bowlers observed in participation?

What is the relationship between performance and forms and habits of bowlers?

What effect, either favorably or unfavorably, do certain psychological factors have on the motor skill performance of bowlers?

What is the relationship between physical characteristics and performance in bowling?

METHOD OF PROCEDURE

The origin, development, and present status of bowling were studied in order to present a historical background of this sport which has become the most popular of all today from the standpoint of participation.[3] The research literature on motor skills was reviewed relative to the methods and techniques used in previous scientific investigations of this subject. The values attributed to bowling in the school physical education curriculum were then presented. An examination of the common pedagogical practices and techniques described in instructional booklets was also made and the results discussed.

Investigation by questionnaire, interview, observation, and collection of scores was conducted concerning certain factors involved in motor skill performance; namely, common practices and habits of bowlers, body type, age, distraction, superstition, recreational preference, waiting interval, upper limit of skill, and the significance of the pattern of skill.

This questionnaire was submitted to the players after a careful study had been made of all the characteristics common to bowlers. In

[1] Gerald Frank, "It's Right Up Your Alley," *Cosmopolitan*, 108 (April 1940) 63.

[2] *America's Youth Goes Bowling, Bowl Your Blues Away.* Chicago: Brunswick-Balke-Collender Co., 1938) pamphlets.

[3] Paul W. Kearney, "Ten Million Keglers Can't Be Wrong," *Esquire*, (February 1937).

constructing the inquiry blank, the writer began by listing and organizing as many items as possible concerning bowling, including even the minor items that seemed less important at the time but which later proved of great value in some cases. This preliminary list contained approximately one hundred twenty-five items. The next step involved the process of eliminating all the factors which were not pertinent to the present study, and organizing the remaining items into a compact form in order to facilitate collection and tabulation of data. With this in view, the advice of bowling instructors, professionals, and expert players was sought. A trip was made to Cleveland, Ohio, to see Mr. Elmer H. Baumgarten, Secretary of the American Bowling Congress, to obtain his suggestions. The blank was then submitted to all the members of the doctoral committee for their suggestions and approval. Finally, Mr. Alan D. Meacham, one of the statisticians of the University of Michigan, was consulted in order to have the items coded to facilitate the tabulation of data on the sorting and tabulating machines.

The distribution of the questionnaire was undertaken by the American Bowling Congress. Mr. Baumgarten, when interviewed concerning the original construction of the inquiry blank, expressed a great interest in this investigation and volunteered to have his office distribute the blanks. This was accomplished by giving the captain of each competing team, when he registered at the desk, five self-addressed envelopes containing inquiry blanks for all members of his team. Bowlers were asked to fill out the blanks and return them as soon as possible. Fifteen thousand questionnaires were distributed in this manner to bowlers participating in the tournament. Of this number 1889 were considered authentic enough to be used in this study.

Performance scores were obtained from the official score sheets. Distribution tables of the data gathered by questionnaire in comparison with the various performance levels are presented and analyzed statistically. The performance score levels used in this study are: under 150, 150-159, 160-169, 170-179, 180-189, 190-199, and 200 and above. The top or perfect score in bowling is 300.

SOURCE OF DATA

The data used in this study were collected and tabulated from many sources. Over one hundred letters requesting instructional manuals, material on the history and development of bowling, and information on modern building and equipment were sent to publishing houses, editors of all bowling magazines, officials of the American Bowling Congress, professionals, instructors, manufacturers of bowling supplies, and managers of large bowling establishments throughout the country. The large quantity of material which was received was used in writing the historical review of bowling and in writing the chapter on the analysis of instructional manuals.

A review of the research in motor learning in sports was made to obtain information that might have a bearing on the problem of this thesis. An extensive search for scientific investigations in bowling was made, but relatively few studies were uncovered.

The data concerning the common practices and habits of bowlers in relation to performance as well as other factors, such as age, distraction, superstition, recreational preference, and upper limit of skill were collected at the 1939 National Tournament of the American Bowling Congress, Cleveland, Ohio. Throughout the entire tournament, which lasted three months, the information concerning these various factors was collected by questionnaires, personal interviews with players, and observations of the bowling characteristics of the same players.

Data for the study of the upper limit of skill were collected by the use of check sheets. On these check sheets were placed the numbers of single pins to be observed; namely, 4, 5, 6, 7, and 10. The purpose was to determine which pins were left standing the greatest number of times and the percentage of hits recorded.

The data for the study of waiting interval were collected in the spring of 1939 from the score sheets of 500 bowlers who participated in the "Above Your Average Tournament" conducted by the Ann Arbor Recreation Alleys. Men who competed in this tournament were not only from Ann Arbor but from many other Michigan cities. The purpose of this tournament was to have each man bowl as far above his submitted average as possible. Submitted averages were based on eighteen previous games. After the scores of the 500 men were tabulated, it was found that only 100 men bowled in all three divisions; namely, five-man, two-man, and individual. For purposes of comparison, therefore, only the scores of the 100 bowlers were analyzed.

The data for the study concerning the pattern of skill as indicated by score markings of bowlers were gathered from the score sheets of 170 men who competed on teams in the Michigan Union Bowling Tournament, over a period of five months from January to May, inclusive, 1939. These teams were composed of faculty men, business men, and university students.

TEST OF RELIABILITY OF INFORMATION OBTAINED FROM QUESTIONNAIRES

In order to obtain a check on the reliability of the data gathered by the questionnaire, the writer made a trip to Cleveland and spent several days collecting information by an observational check sheet method. Bowlers were observed and checked according to what they did in reference to the following items: right-handed or left-handed grip, number of steps taken in approach, approach started with right or left foot, kind of delivery, speed of ball, side of the alley from which approach was made for a strike, and the position on angle shooting

both for the number 7 pin and for the number 10 pin. Other items were also noted as: distraction of players by balls returning to racks, distraction of bowlers making approaches in different alleys simultaneously, and the kind of stance used by participants.

A 97 per cent degree of reliability was obtained in the following manner. Check sheets, which have already been described, were used in observing 50 men on 11 different items. These players were observed on three separate days at different times of the day. The scores of the bowlers ranged from 175 to 225. These observations, made on the 50 men, were checked against the answers which the same men gave on the questionnaire.

By this means of observational checking it is shown in the statements that data concerning grip are the most reliable. This is due, possibly, to the fact that bowlers are more easily observed on this item and, also, that players are not likely to change their style of grip while bowling in a tournament. Data concerning speed are shown to be the least reliable. This is due, possibly, to the difficulty of both the observer and the players to define slow, medium, and fast speeds identically. All the items, however, have high degree of reliability. This shows that authentic information was collected by the questionnaires covering this sampling data and indicates that highly reliable facts were also gathered from the remaining questionnaires.

METHODS USED IN TREATING THE DATA

Instructional manuals were studied and the information was presented and analyzed in chart form. Data collected by the questionnaires were analyzed statistically. An explanatory table is given here with all the formulae used together with computations.

Example

THE DISTRIBUTION OF THE SCORES OF LEFT-HANDED BOWLERS

Class Interval	Frequency f	Deviation d	fd	fd^2
< 150	1	−3	−3	9
150–159	2	−2	−4	8
160–169	6	−1	−6	6
170–179	19	0	0	0
180–189	27	1	27	27
190–199	7	2	14	28
> 200	2	3	6	18
Total	64		34	96

$N = \Sigma f = 64$, $\Sigma fd = 34$, $\Sigma fd^2 = 96$

h = The width of the class interval = 10

A = The class mark of the class with deviation zero = 174.5

M = The arithmetic mean of the scores.

σ = The standard deviation of the scores.

$$M = A + h\frac{\Sigma fd}{N} = 174.5 + 10\frac{34}{64} = 174.5 + 5.31 = 179.81$$

$$= h\sqrt{\frac{\Sigma fd^2}{N} - \left(\frac{\Sigma fd}{N}\right)^2}$$

$$= (10)\sqrt{\left(\frac{96}{64}\right) - \left(\frac{34}{64}\right)^2} = (10)\sqrt{1.5 - (0.5313)^2}$$

$$= (10)\sqrt{1.2177} = (10)\ (1.1034) = 11.035$$

σM = The standard error of the mean

$$\sigma M = \frac{\sigma}{\sqrt{N}} = \frac{11.035}{\sqrt{64}} = \frac{11.035}{8} = 1.379$$

$\sigma M_2 - M_1$ = The standard error of the difference of two means M_1 and M_2. In Table I the data for right-handed bowlers show that M_1 is 179.81, M_2 is 183.28, σM_1 is 1.379, and σM_2 is 0.257.

$$\sigma M_2 - M_1 = \sqrt{\sigma M_1^2 + \sigma M_2^2} = \sqrt{(1.379 + (0.257)^2}$$

$$= \sqrt{1.9016 - 0.0660} = \sqrt{1.9676} = 1.403$$

The critical ratio is found by dividing the difference of the two means by the standard error of the difference of the two means. This ratio is expressed by the formula

$$t = \frac{M_2 - M_1}{M_2 - M_1} = \frac{183.28 - 179.81}{1.403} = \frac{3.47}{1.403} = 2.47^*$$

The asterisk (*) is used to indicate that the difference is significant. This is the usual way of testing for significance. When t is greater than two, it is considered large enough to be significant.[4] The chance that a t value of two or greater will occur is one in twenty-two trials.[5]

Although results measured in this way are significant, other relations may appear because of considerable overlapping of individual performance. For example, right-handed bowlers have a higher average score than left-handed bowlers, but some of the left-handed players may have a higher individual score than some of the right-handed players. On the whole, however, the right-handed bowlers are more likely to have a higher score.

Correlation coefficients between physical characteristics and performance were computed by "The Mendenhall-Warren-Hollerith Correlation Method."[6] This procedure of finding correlations employed the Pearson product-moment method. Scatter diagrams were employed to break down the information into further units of computation.

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[4] R. A. Fisher, *Statistical Methods for Research Workers* (London: Oliver and Boyd, 1925) 45.

[5] *Ibid.*, 74.

[6] R. M. Mendenhall and R. Warren, "The Mendenhall-Warren-Hollerith Correlation Method," *Columbia University Statistical Bureau, Document* No. 1, 1929 (New York: Columbia University Press) 43.

FINDINGS AND CONCLUSIONS

In the part of the study devoted to analysis of instructional manuals it was shown that the following fundamentals and instructional methods were considered most important.

Analysis of the data about the selection of ball shows that the weight of opinion favors the following type of ball: black; two finger; snugly fitting and slightly pitched holes with a natural span, thus enabling a player to keep his ball under better control. A light-weight ball is recommended for the beginner, but an official ball, sixteen pounds in weight and twenty-seven inches in circumference, is advised for the more experienced player.

The body position at the starting line can be described from the weight of evidence of the above items as: feet together, weight distributed on both feet for perfect balance, shoulders parallel to foul line, and ball supported by the left hand held waist high.

The weight of opinion of the ten authors concerning the items under delivery is given below. Personal preference determines the number of steps to be taken to the foul line, while the average starting distance is thirteen feet. The starting distance, however, is dependent upon the number of steps used. The more steps taken the greater the starting distance will be. The speed of approach is classified as medium. Likewise the speed is dependent upon the number of steps used and the length of the starting distance. The position of the thumb on release for the straight ball delivery is forward, for the hook ball delivery it is left, and for the back-up ball delivery it is right. No definite degree of turning of the thumb to the respective direction is given. The time of thumb release from the ball both for straight delivery and for hook ball delivery is before the fingers. No comment is made on back-up ball delivery. The ball is to be laid on the alley and not lofted or pitched. The type of delivery advised for novice players is a straight ball, and for experienced players is a hook ball.

The hands start the swing with a forward push toward the foul line. The direction of approach to the foul line is straight and not wavering or swaying.

According to the weight of evidence given, the body position at the finish of the approach is as follows: the left foot foremost with the toe pointed forward; the right foot back with the toe pointed slightly to the right; the knees bent; the back straight and bent at the hips only; the left arm swung left for balance; and the right arm swung forward.

In strike bowling with straight ball delivery, most of the writers recommend the use of the spot and pins-sighting system. They recommend that the bowler aim at the 1–3 pocket and start the approach on the right side of the alley.

In strike bowling with hook ball delivery, most writers recommend

using the spot and pin method of sighting, aiming at the 1–3 pocket and starting the approach about the middle of the right side.

In strike bowling with a back-up ball delivery, only a few writers have anything to say. Those who do discuss this subject mention most often the spot and pin method of sighting. They also mention most often number 1 pin as the point of aim and the corner of the right side of the alley as the starting position.

Very few authors give information on single spare bowling with straight ball delivery. Those who mention number 7 spare bowling agree that the pin is the mark at which to shoot and that the right side of the alley is the position from which to start. Those who mention number 10 spare bowling agree that the pin is the mark at which to shoot but disagree on the position on the alley from which to start. The recommendations include positions on either side of the alley. One writer advises using a back-up ball delivery for number 10 pin from the corner of the left side of the alley.

Only one-half of the books contain any statements relative to number 7 spare and number 10 spare bowling with hook ball delivery. All the authors who mention number 7 spare bowling agree that the pin is the point of aim to use, and the majority of the writers state that the right side is the position from which to shoot. No reference, however, is made to any definite spot on the right side. All the writers who mention number 10 pin agree that the pin is the point of aim to use, but practically all disagree on the position from which to shoot. The positions given vary from the left side, the center of the left side, to the corner of the left side. One author advises using a back-up ball delivery from the corner of the left side for a number 10 spare.

In single spare bowling with back-up ball delivery, it is impossible to indicate the weight of evidence because too few authors discuss this topic and the statements which are given are too varied.

A study of the charts collectively shows that less information is given on back-up ball delivery for both strike and spare bowling than any other topic analyzed. The reason for this may be that authors feel that back-up ball delivery is not important enough to include in a manual since this kind of delivery is less effective than the straight or hook ball delivery.

Also, less information is given on spare bowling with straight, hook, and back-up ball deliveries than on strike bowling with the same deliveries. Since high scoring is greatly dependent upon the ability to bowl spares, this important phase of bowling receives little attention from the writers in comparison with other aspects of form.

The charts show in several places the use of different terms to describe the same item. For example, the point of aim for strike bowling is described by some authors as to the right of number 1 pin and by others as the 1–3 pocket. If these terms are the same, one or the other

should be adopted, or if both are used, reference should be made in the text to the effect that they are the same. Inconsistency in the use of terms is confusing to the reader and should be eliminated if possible. It will be helpful if definite and uniform expressions are adopted in the near future by all authors of bowling articles and manuals.

The charts also show that most of the manuals do not cover adequately all the essential fundamentals of bowling. One author emphasizes a particular phase more than another or entirely disregards a topic on which another has written at length. It is apparent from the foregoing statements that there is a need for improved and unified methods of instruction in bowling.

Players with certain forms and habits were shown by statistical computation to be, on the whole, the best performers; and this evidence may be indicative of the efficacy of these forms and habits to performance. It was demonstrated that bowlers who used the following techniques were superior:

Right-handed delivery.
Two-finger balls.
Approach of four or five steps.
Straight ball with sharp hook delivery or straight ball with wide hook delivery.
Upright stance with ball chest high or upright stance with ball waist high.
Sighting at spots, or pins and spots when shooting for strikes.
Sighting at spots, or pins and spots when shooting for spares.
Aiming at 3-6, or 6 pins in bowling for strikes when point of aim is on pins.
Aiming at spot on the alley over 10 feet from the foul line.
Middle position on alley for strikes.
Right position on alley for number 7 spares.
Left position on alley for number 10 spares.

No difference in performance was demonstrated between bowlers who did or did not change from hook ball deliveries for strikes to straight ball deliveries for spares. A close relationship between forms and habits of bowlers and instructions given in manuals was found for all items of instruction for which information was available. Considerable information concerning the fundamentals of bowling, instructional methods, and forms and habits of bowlers was uncovered by this study and should prove to be valuable material from which to develop a new manual on bowling.

Certain factors were demonstrated to have had apparently some psychological effect on performance. It was shown that there is an association between distraction and performance. The results seemed to indicate that the better bowlers felt that distractions lowered their performance so waited until the disturbance was over.

Superstitions were more prevalent among the bowlers whose scores

were above 160. This might be interpreted as meaning that the more skilled performers were more temperamental about their playing conditions.

Practice, too, had its effect on performance. Bowlers who practiced three times a week and players who practiced less than one-half hour per period were the best performers. These results would seem to indicate that there is an association between interval of practice and performance; also between the length of the practice period and performance.

Diurnal and seasonal changes were shown to be related to performance. The players who bowled in the mornings and in the evenings, and those who played during the winter months had the best performance.

The factor of waiting interval had no significant effect on the performance of the players in this study. By waiting interval is meant the lapse of time between turns at play as represented in the five-man, two-man, and individual competition.

Patterns of skill were computed for each performance group. For example, on the average, a bowler of the 120–129 group would be expected to receive 1.6 strikes, 2.9 spares, 1.10 splits, and 4.4 misses. A bowler of the 180–189 performance group would be expected to receive 3.5 strikes, 4.2 spares, 0.9 splits, and 1.3 misses. From these two performance groups and from the others as shown in the data, it is readily seen that the number of splits was practically the same for all groups. The greatest difference between groups in markings was shown by misses, followed by strikes, and then by spares. Thus, if a bowler knows his own marking pattern and the marking pattern of the best bowlers, he can easily determine on what part of his game to concentrate. Through a functional relationship of skill and thought patterns, it is possible that a player may be aided in improving his performance.

The relationships between physical characteristics such as height, weight, age, and other important items of bowling such as speed, stance, steps, and performance were too small to be predictive. The results were somewhat indicative that certain relationships did exist, but, on the whole, gave little conclusive evidence. It is possible that a future study covering a general sampling of bowling performance would show other relationships between these items.

Many other investigations are suggested by this study. The most important of these, perhaps, would be the experimental analysis of physical characteristics and psychological factors in bowling. Studies of learning and relaxation would be equally important in revealing different aspects of how skill in this sport is achieved. The results would represent needed contributions to the improvement of bowling skill and to motor learning in general, as well as to the advancement of scientific investigation in physical education.

SIGNIFICANT CONTRIBUTION

There has been collected a large quantity of suitable material from which a textbook on bowling can be written. The analysis of the present-day manuals indicates there is a need for an instruction booklet which will unify and clarify the various methods of teaching bowling. Moreover, a definite and positive approach has been made to determine the superiority of certain habits of skill in bowling which have heretofore been considered controversial. This study measures the *status quo* of bowling ability among players and shows the pattern of superior skill, but does not tell how to obtain this ability in the most economical way. The solution of the problem of how to obtain skill most efficiently would be the assignment of another study.

Finally it is expected that this investigation will aid in shedding additional light on the problem of motor learning in general.

The Relation of Height and Weight Measurements to Intelligence and to Dominance-Submission Among a Group of College Freshmen

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THE purpose of this study is twofold: (1) to discover to what extent intelligence is related to height and weight among a group of college freshmen of both sexes; (2) to determine in what way the dominance-submission aspect of personality of these subjects is correlated with height and weight measurements.

INTRODUCTION

There still appears to be a considerable amount of confusion with reference to the relationship which exists between intelligence and height and between intelligence and weight. On the one hand, there are those (mostly laymen) who are of the opinion that highly gifted individuals (especially precocious children) are likely to be the unfortunate possessors of puny, undersized bodies, while mentally substandard persons are likely to have large and strong physiques (the "strong back and weak mind" concept). On the other hand, there are those who believe that extremely intelligent persons are usually taller and heavier than average persons of the same age.

Sir Francis Galton, early in his scientific career, came to the conclusion that men of genius tend to be above average in height and weight. In 1869 he stated in his *Hereditary Genius*:[6, 321*]

> There is a prevalent belief that men of genius are unhealthy, puny beings —all brain and no muscle—weak-sighted, and generally of poor constitutions. I think most of my readers would be surprised at the stature and physical frames of the heroes of history, who fill my pages, if they could be assembled together in a hall. I would undertake to pick out of any group of them, even out of that of the Divines, an "eleven" who should compete in any physical feats whatever, against similar selections from groups of twice or thrice their numbers, taken at haphazard from equally well-fed classes . . . I do not deny that many men of extraordinary mental gifts have had wretched constitutions, but deny them to be an essential or even the usual

*Superior figures refer to: first, numbered reference at end of article; second, page number within the reference.

accompaniment . . . A collection of living magnets in various branches of intellectual achievement is always a feast to my eyes; being as they are, such massive, vigorous, capable-looking animals.*

Since 1869, when Galton published his original observation relative to the weights and heights of men of genius, many attempts have been made to verify his hypothesis. The results have been conflicting; some have affirmed and others have denied the existence of a sizeable correlation between intellectual capacity and height or weight. Galton's enviable reputation as a nineteenth-century scientist has, without doubt, greatly influenced research on morphological theories of intelligence and temperament during the last half century.

One present-day source of scientific evidence which tends to emphasize the possible significance of physique as a correlate of mentality comes from the field of endocrinology. Endocrinologists have found, for example, that a deficiency of thyroxin from the thyroid gland in the early years of development produces cretinism. Likewise, an undersecretion of tethelin from the anterior lobe of the pituitary gland produces a dwarfed condition; a hypersecretion of tethelin early in life causes gigantism. Accompanying these physical anomalies are mental changes. Thus, the Cretin is dull and the hypo-pituitary dwarf shows a tendency to become mentally torpid. Inasmuch as these scientific findings indicate clearly that abnormalities of glandular functions (especially those of the thyroid and the ante-pituitary) point toward a mental and physical involvement, it would seem to be logical, as Paterson has suggested, that one might *assume* that a malfunctioning of these endocrines provides a *common cause* which might produce a correlation between physical growth and mental development.[12, 27] Nevertheless, Paterson speaks with proper scientific caution:

> The absence of any close correlation between physical size and intellect suggests rather strongly that the glands of internal secretion which control growth do not afford a common factor affecting physical growth and mental growth alike to the same extent. It may be true, of course, that growth-controlling glandular secretions do so operate but that the scope of such single control is limited merely to a minor role in the unfoldment of hereditary potentialities for physical and mental development, such hereditary factors being numerous and independently variable.[12, 78]

The majority of studies made on the relationship between intelligence and height or weight have been conducted with groups of children. This is as it should be.

The fact that tallness or shortness is a surprisingly constant characteristic for any individual child at all ages and that brightness or dullness is likewise

*It is interesting to note that Galton discarded this point of view in 1891. He then wrote: "The experience gained by the measurement of about 2,000 students at Cambridge conclusively proves that success in literary examinations is in no manner connected with stature, weight, strength, or breathing capacity, and but slightly with keenness of eyesight." [7, 55]

surprisingly constant for the individual child, in spite of rapid accelerations in both respects, naturally suggests the greater profitableness of studying the relationship between physical size and intelligence during childhood rather than later.[12, 27]

Studies which make use of adult subjects are, for the most part, not as valuable as those which are restricted to children, because in most of the adult studies the subjects have been limited exclusively to college students. College students form a selected group mentally, economically, and socially;* they neither constitute a random sampling of the adult population as a whole, nor do they form a representative sampling of individuals of their own age. This greater homogeneity of the adult group naturally has the effect of lowering the correlations between stature and weight on the one hand and intellect on the other. This is not to say, of course, that studies which are restricted to college students, especially freshmen, are without value. Indeed, they do have significance. With respect to adolescent and adult groups, one might read with profit the studies reported by Brooks [3] and Sommerville.[14] In the investigations of both children and adults there appear to be slight positive relationships between intelligence and height or weight; yet the correlations are so small that it is not possible to use height or weight as means of predicting the probable intelligence level of any given individual. Perhaps the important point to emphasize is the fact that physical status and intellectual status are largely independent of each other.

Several attempts have been made to prove that physique is diagnostic of conduct. For example, the idea has sometimes been maintained that tall men are more aggressive than short men, that they make more successful salesmen, that they are more often selected as leaders, etc. In other words, height in the male is considered to be a genuine asset wherever masterfulness, dominance, or authority is necessary. Investigations of these frequently mentioned relationships have been made by Terman,[17] Gowin,[8] Caldwell,[4] Nutting,[11] Kitson,[10] Bowden,[2] Bellingrath,[1] and Hunter and Jordan.[9] Symonds, in commenting on the relationship between leadership and physical indices, points out that, although height and weight are positively correlated with leadership, the overlapping is so great that it would never be safe to select candi-

*In studies on the relationship between intelligence and height or weight, it is at least possible that social status may be responsible for the slight positive correlations that are found. As early as 1906, Pearson pointed out: "Nurture, exercise, and nourishment—shortly environment and class—district or local race, influence extensively the anthropometric measurements. We cannot compare pauper imbeciles or hospital post-mortem results with middle class students and professors." [18, 122] More recently, Sorokin has demonstrated that differences in physical measurements are to be found among representatives of higher and lower social groups.[15] As far as the authors have knowledge, there is no available evidence that the small coefficients of correlation between physique and intelligence would be reduced to zero if the factor of social status were held constant by statistical techniques. Perhaps social status is only a secondary factor to be reckoned with. If so, it would not be considered, as Patterson has suggested, a causal factor responsible for the physical and mental correlation.[12, 74]

dates for positions of responsibility on the basis of height and weight alone.[16,507]

The claim has also frequently been made that there is a close relationship between physique and temperament. For example, men who are short of stature are said to possess a strong feeling of inferiority, which, according to Adlerian theory, prompts them to compensate for their physical inadequacy by attempting to become superior in various ways. In like manner, we are often told that tall women possess an inferiority feeling *because of* their abnormal height. Faterson [5] made a study of this problem, using as a measure of inferiority the Heidbreder Inferiority Attitude Self-Rating Scale.* She found that, for 673 freshman men at the University of Minnesota, the correlations between inferiority score and height and weight separately were negligible. However, for 531 freshmen women, there was a correlation of $.10 \pm .03$ between inferiority score and height and a correlation of $-.10 \pm .03$ between inferiority score and weight. Faterson concludes from these data that the low correlations for the men do not indicate that the undersized man is likely to manifest characteristics of superiority as a result of his compensation for feelings of inferiority. The correlations for the women indicate that there is a slight tendency for them to feel inferior when they are above average female height. Overweight, however, does not appear to cause them to have higher inferiority scores.

METHOD AND RESULTS

Masurements of 490 DePauw University freshmen (235 men and 255 women) are included in the present study.† The ages of these students are indicated in Table I. This table shows that 81 per cent of the

TABLE 1
AGES OF STUDENTS BY YEARS

Group	Year 16	Per Cent	Year 17	Per Cent	Year 18	Per Cent	Year 19	Per Cent	Year 20 and over	Per Cent
Men....	5	2	68	26	119	54	28	13	10	5
Women..	3	1	104	45	121	49	16	7	2	0.9
Total..	8	1.6	172	31	240	50	44	9	12	3

subjects are in their seventeenth or eighteenth year, and, because of this homogeneity, the age factor is not partialed out in this investigation.

The measurements of height and weight were made as a routine

* The odd-even reliability of this scale is $.72 \pm .02$; when corrected by the Spearman-Brown prophecy formula the reliability is increased to $.84 \pm .10$.

† The present study does not include data from the total number of DePauw University freshmen. The personality scale was not administered to all freshmen students because of certain difficulties which arose unexpectedly at the time the test was scheduled. However, all subjects used in this study were unselected; we may conclude, therefore, that we are dealing with a representative sampling of freshmen.

part of the physical examination of all freshmen during orientation week of the 1939–40 school year. Standing height was measured with the shoes removed, with the heels together, and with the chin neither unduly raised nor lowered. The centimeter unit of measurement was used. The weights of both men and women were taken with the clothing removed; the kilogram was adopted as the unit of measurement.

Two weeks after the physical measurements had been secured, the Bernreuter Personality Inventory was administered to the subjects. Although all six traits (or qualities) measured by the Bernreuter scale were scored, only scores on dominance-submission (the B4-D scale) are dealt with in the present study, inasmuch as the authors are primarily interested in the relationship between this particular aspect of personality and height or weight. Persons scoring high on the B4-D scale tend to be masterful and dominant in face-to-face situations; those who score low tend to be submissive.* Intelligence scores on the American Council on Education Psychological Examination (1939 Edition), administered during orientation week, were also available; this made it possible to correlate intelligence with both height and weight.

Table II shows the means and standard deviations of the 490 freshmen (men, women, and total) with respect to measurements of height, weight, intelligence, and dominance-submission. In reading this table

TABLE II

MEANS AND S.D.'S OF 490 COLLEGE FRESHMEN WITH RESPECT TO MEASUREMENTS OF HEIGHT, WEIGHT, INTELLIGENCE, AND DOMINANCE-SUBMISSION

Types of Measurement	Mean			Standard Deviation		
	Men (N = 235)	Women (N = 255)	Total (N = 490)	Men (N = 235)	Women (N = 255)	Total (N = 490)
Height*	176.0	164.6	170.0	7.1	4.5	5.7
Weight†	66.5	55.0	60.6	9.4	6.8	9.5
Intelligence‡	111.9	96.4	104.1	31.2	27.8	28.6
Dominance-submission¶	58.5	50.4	54.8	29.3	26.6	28.3

* In terms of centimeters.
† In terms of kilograms.
‡ In terms of raw scores as measured by the American Council on Education Psychological Examination (1939 Edition).
¶ In terms of percentiles for men and women from the Bernreuter Personality Inventory.

one should keep in mind the fact that the dominance percentiles are derived from separate sex norms. Comparisons, therefore, should be made with this fact taken into consideration. The men show the highest mean measurement in all four variables; they are not only taller and heavier on the average (as one would naturally expect), but they are more intelligent and more dominant. The average man is 11.4 cen-

* The items in this scale are based on the Allport Ascendance-Submission Reaction Study. The reliability of the B4-D scale is .89.

timeters taller than the average woman, he is 11.5 kilograms heavier, he has an intelligence score 15.5 higher, and he is 8.1 percentile points above the average woman in dominance measurement.* As for measurement of variability, the men have higher S.D.'s in all four variables.

Table III shows the product-moment correlations between height and intelligence, weight and intelligence, height and dominance-submission, and weight and dominance-submission for the men and women subjects and for the total group. The correlation between height and intelligence for the group is .22 ± .03 (.25 ± .04 for the men and .29 ± .03 for the women). Thus, height shows a slight positive correlation with intelligence; sex differences in size of correlation are negligible. The correlation between weight and intelligence for the group is .15 ± .03 (.18 ± .04 for the men and .19 ± .04 for the women). Weight does not correlate as highly with intelligence as does height. There is no sex difference in size of correlation between weight and intelligence.

TABLE III

CORRELATIONS BETWEEN HEIGHT AND INTELLIGENCE, WEIGHT AND INTELLIGENCE, HEIGHT AND DOMINANCE-SUBMISSION, AND WEIGHT AND DOMINANCE-SUBMISSION

Measurements Correlated	Men (N = 235)		Women (N = 255)		Total (N = 490)	
	r	*PEr*	*r*	*PEr*	*r*	*PEr*
Height and intelligence	.25	.04	.29	.03	.22	.03
Weight and intelligence	.18	.04	.19	.04	.15	.03
Height and dominance-submission	.04	.05	.58	.04	.30	.03
Weight and dominance-submission	.08	.05	−.24	.05	−.10	.03

The correlation between height and dominance for the group is .30 ± .03 (.04 ± .05 for the men and .58 ± .04 for the women). Whereas there is no relationship between height and dominance for men, tall women seem to be definitely dominant. The correlation for the total group (.30) is not significant, since it is too much affected by the high correlation found among the women. The correlation between weight and dominance for the group is −.10 ± .03 (.08 ± .05 for the men and −.24 ± .05 for the women). Again, there is no relationship between weight and dominance among the men, but there is a slight tendency for heavy women to be submissive.

*Perhaps it should be repeated that in comparing men and women on the basis of dominance percentiles, one must keep in mind the fact that the percentiles are based on separate sex norms.

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The Determination and Measurement of Body Build in Men and Women College Students

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THE purposes of these studies* were: (1) to evaluate a number of anthropometric indices most frequently used in determining body build, (2) to determine which anthropometric measurements best indicate the body build of any given individual, (3) to T-scale the best of these indices, and (4) to determine whether or not there are separate and distinct categories of body build in male and female college students.

REVIEW OF LITERATURE

The literature was studied with three purposes in mind: (1) to ascertain how body build has been defined or described, (2) to learn of the methods employed in studying body build, and (3) to secure representative indices which had been proposed for designating body builds.

Some of the literature studied revealed that general body build has been accepted as varying from an extreme linear to an extreme lateral type throughout a continuous, unimodal distribution. Such investigators as Wertheimer and Hesketh,[2]† McCloy,[1] Burchard,[21] Plattner,[8] Weisenfield,[9] Saltykow,[11] Molitch,[10] Heidbreder,[16] Campbell,[22] Jackson,[35] Harris,[38] Dublin,[39] Draper,[26] and Sargent,[49] hold to this view.

On the other hand many other authors have described body build in terms of individual differences distinctly observable between types. For example, Kretschmer[3] has distinguished between his male aesthenic and athletic types by regarding the aesthenic as being "deficient in thickness combined with an average unlessened length" and the athletic as having a strong development of skeleton, musculature, and

* This article combines the doctoral dissertations of N. M. Jorgensen, "The Determination and Measurement of Body Build in College Men," August 1939, and S. Lucille Hatlestad, "The Determination and Measurement of Body Build in College Women," January 1940, on file in the library of the State University of Iowa.

†Refer to numbered Bibliography at the end of this article.

skin." Very detailed distinguishing features of each of four types (including his dysplastics) have been furnished by Kretschmer.[3] Stockard[41] has said that there should be but two extreme types, a linear and a lateral, which will grade regularly into each other. He based this theory on the peculiar activity of the very sensitive thyroid gland which is the "central body tending to control the rate of oxidation and therefore the growth rate in the individual. . . . If the thyroid does regulate growth rate it must also tend to determine structural types. . . . Since the intermediate ideally balanced or indifferent condition would be the most difficult to attain on the part of the sensitive gland, which responds differently in different environments, the two types may be quite well separated. Also there are many persons who do not properly fall into either of the well-recognized types, and are not truly intermediates or blends of the two types, but are type hybrids or type mixtures." For a perusal of the various kinds of these types of classification which have been made throughout the history of the study of body build by some thirty different investigators, reference may be made to summaries made by Wertheimer and Hesketh,[2] Draper,[26] Martin,[12] and McCloy.[1]

Fundamentally, there seems to be a concept of general body build held in common by most investigators. This concept may be stated or defined broadly as the width-depth-length, or weight-length relationships in a person's body relative to others of the group studied. However, opinions as to the methods of describing body build vary. There are those who prefer the subjective description; some who prefer a combination of the subjective and objective descriptions; and others who prefer the totally objective description.

Bean,[27] in defense of the descriptions he has made of his hypo-onto-morph, meso-onto-morph and hyper-onto-morph types, has stated, "the most exact anthropologists decree that nothing shall be accepted that is not exactly measured or defined; yet there are certain qualities which can be described more accurately than they can be measured." Kretschmer,[3] likewise, wrote, "the tape measure sees nothing; it never leads us to a grasp of the biological types which are our object. However, anthropometry aids by strengthening, not negating, the description of the individual." Burchard's[21] criticism is characteristic of the group of investigators which prefers the method of describing the individual objectively in comparison with a group tendency. He wrote, "Kretschmer's methodology is objectional because it cannot be verified or negated by other experimenters. It is difficult for anyone else to apply the same technique with assurance. Nowhere is there a clear-cut, unambiguous criterion for different physical types. No one, untrained in Kretschmer's laboratory, can be sure he is classifying the same. With such ambiguous criteria, subjective bias can play such a part as to make conclusions based upon them of dubious reliability."

To objectify the methods of classification, a number of investigators use indices or ratios of various anthropometric measurements. A summary of the most frequently mentioned indices is listed below:

1. $\frac{\text{Weight}^{1/3}}{\text{Height}}$ (7)
2. $\frac{\text{Weight}}{\text{Height}^3}$ (12)
3. $\frac{\text{Chest girth}}{\text{Height}}$ (7)
4. $\frac{\text{Sitting height}}{\text{Height}}$ (13)
5. $\frac{\text{Trunk height}}{\text{Height}}$ (8)
6. $\frac{\text{Shoulder width}}{\text{Height}}$ (12)
7. $\frac{\text{Arm length}}{\text{Height}}$ (9)
8. $\frac{\text{Leg length}}{\text{Height}}$ (9)
9. $\frac{\text{Hip width}}{\text{Height}}$ (10)
10. $\frac{\text{Shoulder width}}{\text{Chest girth}}$ (14)
11. $\frac{\text{Leg length}}{\text{Chest girth}}$ (8)
12. $\frac{\text{Trunk height}}{\text{Leg length}}$ (2)
13. $\frac{\text{Hip width}}{\text{Leg length}}$ (2)
14. $\frac{\text{Trunk height}}{\text{Waist girth}}$ (8)
15. $\frac{\text{Hip width}}{\text{Shoulder width}}$ (11)
16. $\frac{\text{Chest width}}{\text{Hip width}}$ (11)
17. $\frac{\text{Shoulder width}}{\text{Trunk height}}$ (9)
18. $\frac{\text{Chest width}}{\text{Chest depth}}$ (11)
19. $\frac{\text{Leg length}^3}{\text{Chest width} \times \text{chest depth} \times \text{trunk height}}$ (2)
20. $\frac{\text{Chest width} \times \text{chest depth} \times \text{trunk height}}{\text{Height}^3}$ (8)
21. $\frac{\text{Arm length} + \text{leg length}}{\text{Sitting height}}$ (11)
22. $\frac{\text{Leg length}}{\text{Chest width} + \text{chest depth}}$ (15)
23. $\frac{\text{Weight}}{\text{Height}}$ (16)
24. $\frac{\text{Weight}}{\text{Height}^2}$ (17)
25. $\frac{\text{Weight}^2}{\text{Sitting height} \times \text{weight}}$ (9)
26. $\frac{\text{Chest girth} + \text{abdomen girth} + \text{hip girth} + \text{weight}}{\text{Height}}$ (14)
27. Height — (chest girth + weight) (14)

28. $\frac{\text{Head height} \times \text{hand girth} \times \text{shoulder width} \times \text{chest girth}}{1000}$ (14)

29. $\frac{\text{Height} \times 10{,}000}{\text{Chest width} \times \text{chest depth} \times \text{trunk height} \times \text{shoulder width}}$ (14)

30. $\frac{\text{Chest width} \times \text{chest depth} \times \text{shoulder width}}{\text{Bi-iliac width} \times \text{bi-trochantoric width}}$ (14)

31. $\frac{\text{Shoulder width} \times \text{hand girth} \times \text{arm length} \times \text{leg length}}{\text{Chest girth} \times \text{abdomen girth} \times 100}$ (14)

32. $\frac{\text{Leg length} \times 10}{\text{Chest width} \times \text{chest depth} \times \text{trunk height}}$ (14)

33. $\frac{100\ (\text{chest girth} + \text{abdomen girth}) - (\text{arm length} + \text{leg length})}{\text{Chest width} \times \text{chest depth}}$

THE PROBLEM

These two studies have included: (1) the adoption of a definition of general body build, (2) the development of criteria to be used in selecting indices which would best measure general body build, and (3) the collection of data and selection of methods to be used in analyzing these data to accomplish the purposes stated in this article.

DEFINITION OF BODY BUILD

In considering a concept of build it seems necessary that: (1) it represent the characteristic morphology of the individual as a whole, not one or two measurements which state the proportion between only two small parts of the body, (2) that it represent as nearly as possible the skeletal elements of the individual, (3) that it be as simple as possible. Thus body build is defined as the width-depth relationship of a person compared to his stature.

THE DATA

The subjects for these investigations comprised two hundred women enrolled in physical education classes at the Kansas State Teachers College of Pittsburg, fall semester 1938, and three hundred men students of the State University of Iowa. The age range was from eighteen to twenty years. These students had been pronounced, by the school medical examiners, as being free from observable pathological conditions.

Information with regard to geographic location, and country of birth of the subjects, their parents, and grandparents was collected. The samples undoubtedly represented favored social and economic groups because of the selective nature of college students. They may otherwise be characterized as fairly homogeneous groups with respect to geographic locality and racial stock.

Anthropometric measurements taken included the following:

1. Stature
2. Weight
3. Sitting height
4. Trunk height
5. Arm span
6. Leg length (greater trochanter to floor)
7. Foot length
8. Tibia length (tibiale to syhyrion)
9. Arm length (acromion to dactylion)
10. Humerus length (acromion to radiale)
11. Shoulder width (bi-acromial)
12. Chest depth (xiphoid level)
13. Chest width (xiphoid level)
14. Chest girth (xiphoid level)
15. Elbow width
16. Knee width
17. Hip width (bi-iliac)
18. Head width
19. Hip width (trochanteric)
20. Head length
21. Waist girth (smallest girth of trunk)
22. Abdomen girth (level of umbilicus)
23. Calf girth
24. Forearm girth
25. Skin and subcutaneous tissue at chest front
26. Skin and subcutaneous tissue at abdomen
27. Skin and subcutaneous tissue at chest back
28. Supra-iliac skin and subcutaneous tissue

The measurements were made by using the technique employed in the Iowa Child Welfare Research Station.[1] Where these techniques are not given in the reference cited, they are identical with those given by Hrdlicka.[27] Reliabilities of the measurements were checked by correlating repeated measurements. The correlations ranged from 0.91 to 0.99.

SETTING UP THE CRITERIA

Inasmuch as different criteria were used by the two investigators it becomes necessary here to treat each separately.

Rating Criterion.—In the *study dealing with men,* the common method of using the combined ratings of experts in the field was used as a criterion. The complete procedure used was as follows: 65 male students of the University of Iowa, selected at random, were photographed (nude except for a loin cloth) on a 35 mm. continuous film. Two views were taken, a front and a side view. The subjects stood a standard distance from the camera. While the subjects were being photographed the investigator rated the general body build and shoulder width-hip width relationship of each individual as follows:

Using a five-point scale, "one" represented a slender, narrow built

person in relation to his stature. "Three" represented an average type of build. "Five" included the thick, broad type of person. Intermediate values were designated by their respective values of "two" or "four." In estimating the general build the following regions were observed: front view—width of shoulders, width of thorax, width of waist, biiliac width of hips, and width of extremities in relation to stature; side view—depth of thorax, depth of abdomen, depth at the level of the pubis, and depth of extremities in relation to stature. The rating of the shoulder width-hip width relationship was made for the purpose of testing Kretschmer's hypothesis relating to the existence of an athletic type. This was done on a three-point scale: "one" represented a narrow shoulder width in relation to hip width, "two" indicated an average shoulder width and "three" indicated broad shoulders in relation to hip width.

The 35 mm. film was then projected on a large screen and five experts,* using the same technique for classifying body build as the investigator had used, rated each of the subjects independently.

The results of the ratings of body build showed correlations of 0.80, 0.81, 0.85, 0.91, and 0.92 between the investigator's ratings and the individual ratings of the experts. A correlation of 0.95 was secured when the investigator's rating was compared with the average of the five experts. The reliability of the investigator's rating of the subjects in person and on the screen was 0.96. The ratings of the shoulder-hip width relationship revealed correlations ranging from 0.56 to 0.64 and a reliability of 0.69. The validity of the shoulder-hip width rating was found to be 0.58 by correlating the rating with the actual shoulder-hip width ratio.

An interpretation of the above correlations leads to the conclusion that the investigator's ratings of general body build are sufficiently valid and reliable to justify their use as a criterion for this investigation. He therefore rated each of the three hundred male subjects used in this study on the five-point scale previously described and used these ratings as the final criterion.

The ratings of the shoulder-hip width relationships are less reliable, in light of the low correlations found between the actual measurements and the ratings, and consequently were considered too invalid to justify their use.

In the *study dealing with women,* four criteria were developed. A description of each follows:

Criterion I.—Five experts† classified photographs(which had been

* These experts consisted of two members of the University of Iowa Child Welfare Staff, two members of the Physical Education Staff, and a Ph.D. student of physical growth.

† Two women on the staff of the Women's Department, Division of Physical Education, State University of Iowa; two staff members, one woman and one man, Iowa Child Welfare Research Station, State University of Iowa; and the investigator.

enlarged and printed from the 35 mm. film) of 75 subjects into five and then nine categories, following the same instructions as described for the foregoing Rating Criterion. Each judge's classifications were made by dealing and redealing the photographs into five and then nine piles and scoring each photograph in the five and nine piles from one to five and one to nine respectively.

Statistical analysis of this procedure consisted in correlating the sum of two judges' classifications with the sum of two other judges' classifications, thus determining the objectivity of the four judges. The nine-category classification proved to have the higher degree of objectivity ($r = 0.98$)* when stepped up by the Spearman-Brown formula. The degree of agreement between the investigator's classifications and the sum of the four judges' classifications was 0.94.† Table I gives a summary of analyses of reliability for this and the following criteria.

TABLE I

SUMMARY OF ANALYSES OF RELIABILITY, CRITERIA 1, 2, AND 3
WOMEN COLLEGE STUDENTS

Criteria	Analyses	Number of Subjects	Key* to Correlations	Number of Categories	r values	r Increased by Spearman-Brown Formula
Criterion 1	A	75	(Ip) (1+2+3+4)	5	.86	
	B	75	(I+3) (2+4)	5	.94	.97
	C	75	(Ip) (1+2+3+4)	9	.94	
	D	75	(I+3) (2+4)	9	.97	.98
	E	75	(Ip+1+2+3+4)	5	.98	
			(Ip+1+2+3+4)	9		
Criterion 2	F	155	M (repeated)	5	.84	
	G	155	H (repeated)	5	.88†	
	H	155	$H_{(1+2)}$ $M_{(1+2)}$	5	.81	.89†
Criterion 3	I	155	(H) (M)	7	.81	.89
	J	155	(H) (M) (repeated)	7	.85	.92
	K	75	(Hp) (Mp)	7	.89	.92
	L	155	M (repeated)	7	.82	

* (Ip), investigator's classifications.
Numbers (1 to 5), other judge's classifications.
H, investigator's classifications, 155 film.
Hp, investigator's classifications, 75 photographs.
M, other judge's classifications, 155 film.
Mp, other judge's classifications, 75 photographs.
† While r was no higher than the reliability of the investigator (see analysis F), these two were combined to correct for "attenuation."

Criterion 2.—Two of the aforementioned judges classified 155 subjects into five categories from a projection of the film. Attention should be drawn to the fact that these classifications from projected film did not permit constant comparison of individuals as did the dealing of the photographs into piles of similar builds, which was the case in establishing Criterion 1.

* Table I, analysis D.
† Table I, analysis C.

The reliability of each of these two judges was determined to be 0.88 and 0.84.* In combining the four classifications made independently by these two judges, to correct for attenuation, their objectivity was found to be 0.89.†

Criterion 3.—In order to attempt to provide a criterion with a higher degree of validity than either of the preceding two, a photographic scale of builds was devised. Using this scale, two judges made several independent classifications of the film of the 155 subjects by the method of paired comparisons. These were summed in order to provide data on their averaged performance.

Use of this photographic scale for classifying builds provided a method similar to that set up in Criterion 1 wherein reference points were available to the judges, which probably helped refine their judgments and consequently increased the validity of their classifications. Since it was believed that a classification of an entire sample would provide a more valid criterion than the classification of a part of a sample, Criterion 3 met this desire.

Criterion 4.—A fourth criterion, consisting of a purely arbitrary combination of measurements, was developed to ascertain what might happen in an experimental approach. No claims are made for its validity or reliability. It will be presented simply to show what combinations were tried. This type of criterion is not to be recommended until it has been investigated further.

Stated concisely, and showing how the calculations were made for 155 individuals, Criterion 4 is:

Part 1, $\frac{\text{Average hip width}}{\text{Average elbow width}} \times$ each elbow width
plus
$\frac{\text{Average hip width}}{\text{Average knee width}} \times$ each knee width
plus
hip width.

The sum of the above three items was divided by each individual's height. These figures then were T-scored for each individual. Each T-score was multiplied by two, to produce Part 1 of Criterion 4.

Part 2, $\frac{\text{Shoulder width}}{\text{Height}}$ (T-scored for each individual)

Part 3, $\frac{\text{Chest girth}}{\text{Height}}$ (T-scored for each individual)

Part 4, $\frac{\text{Waist girth}}{\text{Height}}$ (T-scored for each individual)

Part 5, $\frac{\text{Sitting height}}{\text{Height}}$ (T-scored for each individual, then multiplied by two)

* Table I, analyses F and G.
† Table I, analysis H.

Adding Parts 1 to 5 gave the total T-score for each individual, which is Criterion 4.

THE USE OF INDICES IN DETERMINING BODY BUILD

An examination of the indices which appeared in the literature revealed the fact that a number of them were obviously invalid. As pointed out by Montessori,[18] weight, a volumetric measure, cannot be expressed in direct relationship to linear measurements but must be reduced to the same power. Further mathematical difficulties of a number of these indices are revealed by McCloy.[1]

A Criterion for Evaluating Indices.—As a criterion for evaluating these indices, the following test was applied to each of the indexes: (1) The value for the particular index under consideration was obtained by using theoretical figures which would apply to an individual of average size. (2) This individual was then "stepped up or magnified" so that he became much larger in size but remained exactly the same in bodily proportions. For example, to step up an individual who is 175 centimeters in stature to what he would be if he were 190 centimeters, multiply each dimension used in both the numerator and the denominator of the index under consideration by 190/175. The same individual of average size was then reduced to a stature of 160 centimeters by the same process as was used in magnifying him. The three resulting indices should be of the same value.

The results of this operation are given in Table II. Indices that did not produce the same value for each of the three hypothetical cases were excluded from further consideration.

DETERMINATION AND MEASUREMENT OF BODY BUILD

Men College Students.—Since different criteria were used for the men and women, individual analyses were necessary.

The indices in Table II which proved to be valid were correlated with the *Rating Criterion.* The results, shown in Table III, reveal the fact that those indices which correlated highest with the *Rating Criterion* comprised measurements of both linear and lateral dimensions. Indices composed of two linear or two lateral measurements produced relatively insignificant correlations.

Further examination was made of those variables contained in the indices which gave the highest correlations with the *Rating Criterion.* Correlations of these measurements with this criterion gave the following results:

Chest girth	.546	Elbow + knee width	.286
Weight	.485	Arm length	—.228
Leg length	—.343	Sitting height	—.175
Height	—.320	Hip width	.148
Shoulder width	.294	Trunk height	.095

Further correlations were made between *weight*$^{1/3}$*/height* and a number of indices which correlated the highest with the *Rating Criterion*. The results revealed that: *leg length/chest width* + *chest depth* had a correlation of —.775; *chest girth/height* had a correlation of .770; *chest width* × *chest depth* × *trunk height/height*^{3} had a correlation of .747.

TABLE II
ON EVALUATION OF ANTHROPOMETRIC INDICES

Index*	160 cms. in stature	175 cms. in stature	190 cms. in stature
1	.032	.032	.032
2	.000013	.000013	.000013
3	.474	.474	.474
4	.526	.526	.526
5	.343	.343	.343
6	.229	.229	.229
7	.446	.446	.446
8	.514	.514	.514
9	.171	.171	.171
10	.482	.482	.482
11	1.084	1.084	1.084
12	.667	.667	.667
13	.333	.333	.333
14	.789	.789	.789
15	.750	.750	.750
16	1.000	1.000	1.000
17	.667	.667	.667
18	1.363	1.363	1.363
19	18.409	18.409	18.409
20	.0072	.0072	.0072
21	1.826	1.826	1.826
22	1.731	1.731	1.731
	(*The following are mathematically invalid*)		
23	.325	.388	.458
24	.001	.002	.003
25	3.855	4.895	4.153
26	1.730	1.794	1.864
27	32.141	24.000	12.817
28	1113.7	1593.6	2214.2
29	1.399	1.105	.913
30	26.006	28.417	30.887
31	7.252	8.674	10.224
32	271.915	227.273	192.789
33	—1.160	—1.061	—.997

* The numbers refer to the corresponding indices given on pages 62–63.

In conclusion, it seems from the foregoing facts that *weight*$^{1/3}$*/ height* is the best single index to determine general body build of men. Other indices which are fairly valid are those referred to in the preceding paragraph. Due to its simplicity, *chest girth/ height* is probably to be preferred in this group.

The *method of factor analysis* is one which causes factors which are common to various groups of variables to emerge and to become subject to quantitative treatment. Since body build has been defined as a

TABLE III
ZERO-ORDER CORRELATIONS WITH BODY BUILD RATINGS (MEN)

Indices	r
1. Weight ⅓ / height	.915
2. Leg length / chest width + chest depth	−.711
3. Chest width × chest depth × trunk height / height³	.710
4. Chest girth / height	.702
5. Leg length / chest girth	−.698
6. Elbow + knee width / height	.560
7. Trunk height / waist girth	−.490
8. Shoulder width / height	.484
9. Hip width / height	.448
10. Hip width / leg length	.400
11. Sitting height / height	.333
12. Shoulder width / chest girth	−.305
13. Trunk height / leg length	.261
14. Shoulder width / trunk height	.251
15. Trunk height / height	.245
16. Chest width / hip width	.228
17. Leg length³ / chest width × chest depth × trunk height	.224
18. Chest width / chest depth	−.182
19. Leg length + arm length / sitting height	−.182
20. Leg length / height	−.151
21. Hip width / shoulder width	−.070
22. Arm length / height	.070

width-depth-stature relationship, it seemed possible that this relationship might be expressed in terms of linear and cross-sectional growth factors. Thurston's multiple factor analysis technique[28] was therefore applied to a number of selected measurements of the three hundred male students.

Three important common factors emerged and were identified as (1) a linear factor most heavily loaded with such measurements as height and tibia length, (2) a cross-sectional factor highest in the chest measurements and arm girths, and (3) a fat factor representing the fat measurements. By the use of multiple regression equations each individual's linear and cross-sectional growth factor values, in terms of T-scores, were secured. Dividing the one value by the other produced an index representing the body build of the individual.

The validity of this method proved to be .602 secured by correlating the *lateral factor/linear factor* with the *Rating Criterion*. Since other simpler indices gave much higher correlations, the use of this approach at present is not advocated. For this reason a detailed account of procedure and results used in this method is not given here.*

Women College Students.—Scattergrams were made of the selected twenty-two indices and each of the four criteria. (See Table II.) Computations were not completed when it was obvious from the scattergrams of two variables that no significant relationship existed between

* The complete procedure may be referred to in the doctoral dissertation of Jorgensen.

TABLE IV
CORRELATION COEFFICIENTS OF CRITERIA WITH INDICES (WOMEN)

Index	Criteria 1	2	3	4
1. Weight$^{1/3}$/height	.83	.82	.89	.81
2. Chest girth/height	.73	.75	.70	.73
3. Leg length/chest girth	—.76	—.69	—.69	—.89
4. Predicted weight$^{1/3}$/height	.67	.73	.68	.85

them. This eliminated from the outset all except those given in Table IV.

It is to be noted that body build in women, as well as in men, is apparently best determined and measured by the indices *weight$^{1/3}$/height, chest girth/height,* and *leg length/chest girth* or *leg length/chest width + chest depth.* Predicted or normal weight was computed and substituted in *weight$^{1/3}$/height.* It is shown above that this index also correlated significantly with the four criteria.

FINDINGS PERTAINING TO DISTINCT CATEGORIES

As has been indicated in the writings on body build, a number of investigators suggest the theory that there are distinct categories of body build. Kretschmer's athletic type is characterized as an average sized individual with wide shoulders and narrow hips. The linear type is characterized by long legs and arms, short trunk and sitting height. Recognition of these views led to the following analyses.

In attempting to determine whether or not there is an athletic type, the hip-width–shoulder-width ratio of each subject was plotted on a scattergram and correlated with *weight$^{1/3}$/height.* The result was a correlation of —.127 for the men and .170 for the women. Investigation of the means of the arrays revealed the fact that there was no tendency for any part of the distribution to regress one way or the other; in other words, wide shoulders were not a characteristic of any part of the distribution but were evenly distributed throughout. By plotting the *hip width/shoulder width* frequencies fairly normal, unimodal curves of both sexes were observed. None was bimodal, as would be expected by the Kretschmerian hypothesis.

Further analyses, made by plotting and correlating *hip width/shoulder width* with *leg length/chest girth* and then with *chest girth/height,* revealed insignificant correlations. Furthermore, the differences between the means of *shoulder width/height* for the three middle categories of body build in women college students were not significant. The means for the three groups were 219, 222, and 220 for categories 2, 3, and 4, with the respective critical ratios being 0.43, 0.79, and 1.96.

In summing up the discussion relative to the existence of an athletic type, evidence from these investigations cannot be interpreted otherwise than indicating negative results. The indices of *shoulder width/height, hip width/height,* and *weight$^{1/3}$/height* all gave distribu-

tions very close to a symmetrical unimodal curve. It is a fact that there are individuals of average size with extremely wide shoulders and there can be no objection to designating these as being of an athletic type, but there is an equal number of individuals with narrow shoulders, and with intermediate shoulders. These are as distinct as the athletic group. The hip-width–shoulder-width relationship for any given individual does not at all indicate where he falls in the whole distribution.

From the facts presented in these studies the investigators believe that body build can best be understood in terms of a continuous distribution from one extreme to the other, with no distinct categorical types as suggested by various writers.

A SCALE FOR DETERMINING THE BODY BUILD OF MEN AND WOMEN COLLEGE STUDENTS

Since the index $weight^{1/3}/height$ consistently correlated highest with all criteria used in both studies, the investigators propose the use of this index as a means of determining body build in both men and women college students. Further reasons for using this index are: (1) it makes no attempt to develop arbitrary and separate categories but assumes a continuous distribution from one end of the group to the other, which seems to have been fairly well established in these studies; (2) the measurements involved are so simple that any layman can take them; (3) it can be quickly and reliably computed.

TABLE V
CUBE ROOT OF WEIGHT

Lb.	Kilo.	Cube Root	Lb.	Kilo.	Cube Root	Lb.	Kilo.	Cube Root	Lb.	Kilo.	Cube Root
99.0	45.0	3.557	125.4	57.0	3.848	151.8	69.0	4.101	178.2	81.0	4.327
100.1	45.5	3.570	126.5	57.5	3.860	152.9	69.5	4.111	179.3	81.5	4.335
101.2	46.0	3.583	127.6	58.0	3.871	154.0	70.0	4.121	180.4	82.0	4.344
102.3	46.5	3.596	128.7	58.5	3.882	155.1	70.5	4.131	181.5	82.5	4.353
103.4	47.0	3.609	129.8	59.0	3.893	156.2	71.0	4.141	182.6	83.0	4.362
104.5	47.5	3.622	130.9	59.5	3.904	157.3	71.5	4.151	183.7	83.5	4.371
105.6	48.0	3.635	132.0	60.0	3.915	158.4	72.0	4.160	184.8	84.0	4.379
106.7	48.5	3.648	133.1	60.5	3.924	159.5	72.5	4.170	185.9	84.5	4.388
107.8	49.0	3.659	134.2	61.0	3.936	160.6	73.0	4.179	187.0	85.0	4.397
108.9	49.5	3.672	135.3	61.5	3.947	161.7	73.5	4.188	188.1	85.5	4.406
110.0	50.0	3.684	136.4	62.0	3.958	162.8	74.0	4.198	189.2	86.0	4.414
111.1	50.5	3.697	137.5	62.5	3.969	163.9	74.5	4.207	190.3	86.5	4.422
112.2	51.0	3.708	138.6	63.0	3.979	165.0	75.0	4.217	191.4	87.0	4.431
113.3	51.5	3.721	139.7	63.5	3.989	166.1	75.5	4.227	192.5	87.5	4.439
114.4	52.0	3.732	140.8	64.0	4.000	167.2	76.0	4.236	193.6	88.0	4.448
115.5	52.5	3.744	141.9	64.5	4.010	168.3	76.5	4.245	194.7	88.5	4.456
116.6	53.0	3.756	143.0	65.0	4.021	169.4	77.0	4.254	195.8	89.0	4.465
117.7	53.5	3.768	144.1	65.5	4.031	170.5	77.5	4.263	196.9	89.5	4.473
118.8	54.0	3.780	145.2	66.0	4.041	171.6	78.0	4.272	198.0	90.0	4.481
119.9	54.5	3.792	146.3	66.5	4.051	172.7	78.5	4.282	199.1	90.5	4.489
121.0	55.0	3.803	147.4	67.0	4.061	173.8	79.0	4.291	200.2	91.0	4.497
122.1	55.5	3.814	148.5	67.5	4.071	174.9	79.5	4.300	201.3	91.5	4.506
123.2	56.0	3.826	149.6	68.0	4.082	176.0	80.0	4.309	202.4	92.0	4.514
124.3	56.5	3.837	150.7	68.5	4.091	177.1	80.5	4.318	203.5	92.5	4.522

Tables have been constructed for the convenience of the student in determining his or her body build. After securing one's actual weight, refer to Table V and obtain the cube root of that weight. Divide this by one's height (in centimeters) and multiply the result by 10,000 to eliminate decimal points. The corresponding T-score value for this figure, given in Table VI, represents the position on a continuum where an individual falls. A T-score of 50 represents the mean, while each 10 points above or below 50 represents one standard deviation from the mean. The T-scores in this table were computed from the data on the 200 women and 300 men students measured in these studies.

TABLE VI
T-SCORE SCALE OF BODY BUILD

Weight⅓ / Height	T-score Men	T-score Women	Weight⅓ / Height	T-score Men	T-score Women	Weight⅓ / Height	T-score Men	T-score Women
208	24.0	21.3	228	48.5	45.0	248	69.2	64.3
209	25.2	22.5	229	50.0	46.0	249	69.9	65.0
210	26.4	23.8	230	51.4	47.2	250	70.5	65.5
211	27.5	25.0	231	52.8	48.3	251	71.7	66.0
212	28.3	26.3	232	54.3	49.0	252	72.9	66.3
213	29.1	27.5	233	55.5	50.0	253	74.0	66.8
214	30.0	28.8	234	56.6	51.2	254	75.8	67.4
215	31.3	30.0	235	57.8	52.4	255	77.6	67.9
216	32.6	31.5	236	58.9	53.6	256	79.4	68.4
217	33.8	32.5	237	59.9	55.0	257	80.8	68.9
218	35.0	33.5	238	61.0	55.7	258	82.2	69.3
219	36.2	35.0	239	62.1	56.5	259	83.5	69.7
220	37.5	36.0	240	63.2	57.9	260	84.7	70.0
221	38.7	37.3	241	64.3	59.0	261	85.9	70.7
222	39.8	39.2	242	64.9	60.0	262	87.1	71.1
223	41.0	40.0	243	65.6	60.8	263	88.1	71.6
224	42.4	40.5	244	66.2	61.4	264	89.0	72.1
225	43.8	41.6	245	67.0	62.2	265	90.0	72.5
226	45.3	42.6	246	67.8	62.8	266	91.7	73.0
227	46.9	43.8	247	68.5	63.6	267	93.4	73.6

One caution should be mentioned in the use of the provided T-score tables. They should be used with subjects from a college-age group, as T-scores computed from one type of data cannot be applied to a totally different kind of group. For example, it would be unwise to apply these standards to young children.

APPLICATIONS

These studies involved no attempt to relate the findings to applications. However, a list of references, covering the relationships of body build to several fields, is appended in the bibliography. The following classification is intended only to assist those who might be interested in locating references of their particular choice.

1. Medicine:
   a) Health (21, 26)
   b) Disease (5, 6, 21, 26, 37)
   c) Anatomy and physiology (4, 5, 6, 7, 10, 35, 36, 38, 41, 48, 54)
   d) Psychiatry (2, 3, 21, 22, 45)

2. Education:
   a) Psychology (2, 3, 16, 20, 21, 22, 24, 30, 31, 33, 34)
   b) Physical education (5, 32, 35, 49, 50, 51)
   c) Child welfare (1, 7, 42, 43, 52)
   d) Anthropology (11, 12, 14, 17, 18, 44, 47)

3. Business and industry:
   a) Occupations (30, 31, 38, 40)
   b) Vital statistics (37, 38, 39)
   c) Clothing manufacturers (46, 55)
   d) Transportation: railway and aviation (refer directly to railway and airways central offices)

SUMMARY AND CONCLUSIONS

The purposes of these studies were: (1) to evaluate a number of anthropometric indices most frequently used in determining body build, (2) to determine which anthropometric measurements best indicate the body build of any given individual, (3) to T-scale the best of these indices, and (4) to determine whether or not there are separate and distinct categories of body build in men and women students.

Subjects for these investigations comprised two hundred women of the Kansas State Teachers College of Pittsburg and three hundred men of the State University of Iowa. Twenty-eight anthropometric measurements were taken on each of these subjects.

Body build was defined as the width-depth-stature relationship within a person. The criterion used in the study dealing with the body build of men was based on subjective ratings of the investigators. Four criteria were established in the study of women. Three of these were based on judgments of experts. The fourth criterion was an arbitrary combination of physical measurements.

Twenty-two different indices were correlated with each of the criteria. The indices which proved to be highly valid for both men and women were: $weight^{1/3}/height$, *chest girth/height* and *leg length/chest girth*. The index $weight^{1/3}/height$ was T-scored, and tables, from which to determine the body build of both men and women, were constructed.

The application of Thurstone's multiple factor analysis to a selected number of measurements taken on the men proved to be a reliable method of isolating growth factors, but the application of these factors to body build did not produce results of sufficiently high reliability to justify its use.

There is no evidence revealed in these studies to support the existence of unique characteristics of distinct types or categories of body build in either men or women college students. The findings seem to indicate a continuous distribution of builds varying from an extreme lateral build at one end of the distribution to an extreme linear build at the other.

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The Effect of a Season of Training and Competition on the Response of the Hearts of High School Boys

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IT HAS been demonstrated that a season of physical training brings about alterations in the response of the heart. It has been shown by Cook and Pembrey,[1]* Schneider,[2] Schneider and Truesdell,[3] Herxheimer,[4] and others, that the heart of a physically well trained man has a slower resting rate, increases less as a result of exercise, and recovers more quickly after exercise than the heart of a healthy untrained individual.

The question as to the effect of strenuous exercise, such as athletic training and competition, on the response of the heart of the school boy is repeatedly raised. This occurs especially where some feel that strenuous exercise in the school program may lead to undue cardiac strain, ultimately resulting in circulatory damage.

The investigation herein reported was set up in an attempt to determine just what the chronic effects of a season of training and competition were on the response of the heart of the high school boy. So as to make the results as meaningful as possible, the experiment was carried out in what is believed to be a representative high school, where the athletic program approximates what one would expect in any high school.

THE PROCEDURE

Fourteen track athletes were selected as subjects for the experiment. Each man participated in a training schedule consisting of 1½ to 2 hours of jogging, sprinting, and distance running, together with work in his special event. In addition, each boy took part in interscholastic competition.

In order to study the response of the heart to exercise, work of measured intensity was performed, each individual doing the same amount of work. The exercise consisted of stool-stepping at the rate of 35 steps per minute as described by Tuttle.[5]

The first step in the experiment was to find the resting heart rate. This was done while the subjects were reclining on a plinth, and after sufficient rest had been acquired so that there was no further drop in

* Refer to numbered Bibliography at end of article.

pulse rate. As soon as the resting rate was established, each subject performed the exercise. Immediately after the cessation of the work the heart rate was counted in ½-minute intervals until it had returned and remained at the resting level.

In order to determine the effects of the training schedule and season of competition on the response of the heart to exercise, the tests were given (1) at the beginning of the season, (2) in mid-season, and (3) at the end of the season.

THE DATA

Data were collected pertaining to six factors related to the effects of the season of training and competition on the response of the heart to exercise. A summary of the data is shown in Table I. The raw data are omitted, thus the data presented are means.

TABLE I

THE EFFECTS OF A SEASON OF TRAINING AND COMPETITION ON THE RESPONSE OF THE HEARTS OF HIGH SCHOOL BOYS TO EXERCISE

	Pre-season	Mid-season	Post-season
Resting rate	34 per ½-min.	33 per ½ min.	34 per ½-min.
Heart rate after exercise	50 per ½-min.	52 per ½-min.	54 per ½-min.
Heart rate above the resting rate after exercise	16 per ½-min.	19 per ½-min.	20 per ½-min.
Primary recovery time	2 minutes	2 minutes	2 minutes
Recovery time	9 minutes	8 minutes	8 minutes
Recovery pulse	355	349	228

1. *Resting Rate.*—The data presented in Table I show that the season of training and competition as carried out in the high school in which the subjects investigated were enrolled, had no significant effect on the resting heart rate. The rate was 33, 34, 33 per ½-minute respectively in pre-season, mid-season, and post-season.

2. *Heart Rate Immediately after Exercise.*—Immediately following the stool-stepping exercise, the count was started. The data show that the mean rate per ½-minute following the exercise is 50, 52, and 54 respectively during pre-season, mid-season, and post-season.* The data indicate that the season of competition and training had no significant effect on the heart rate for the first ½-minute immediately following exercise. Although the trend is upward the difference cannot be regarded as significant.

3. *Heart Rate Increase above the Resting Rate Immediately after Exercise.*—This is the heart rate immediately following exercise minus the resting rate. The data show these values to be 16, 19, and 20 beats per ½-minute respectively for pre-season, mid-season, and post-season.

* A difference in heart rate up to 3 beats per ½-minute is regarded as no change due to the possible error in counting.

Here again, the differences are not significant and are interpreted as showing that the training and competition had but little effect on the response of the heart immediately following exercise.

4. Primary Recovery Time.—The primary recovery time is defined as the time in minutes required for the heart to reach the resting level after exercise. The data show that the primary recovery time is 2 minutes during pre-season, mid-season, and post-season. Obviously the training season and schedule of competition had but little effect on the primary recovery time.

5. Recovery Time.—This is the time in minutes required for the heart rate to reach and remain at the resting level for a period of not less than two minutes. The recovery time before the training season began was 9 minutes, while in mid-season it was 8 minutes, and in post-season 8 minutes. Although there is a drop of one minute from pre-season to post-season, this small difference is not regarded as significant.

6. The Recovery Pulse.—The recovery pulse represents the sum of the heart beats for the period of time between the end of the exercise and the time at which the resting rate is reached and maintained, minus the resting pulse for the same period. Reference to Table I reveals the fact that the recovery pulse in the pre-season experiment was 355 beats and at mid-season it was 349 beats. These figures are not significantly different. However, the post-season recovery pulse was only 228 beats which is significantly less than the two previous figures. This result seems to indicate that the season of training and competition materially reduced the number of heart beats required for bringing about recovery.

In general, the important point brought out by this investigation is that the training schedule and season of competition participated in by the subjects investigated, whom we believe to be representative high school athletes, did not cause the cardiac response changes usually brought about by strenuous physical training. Evidently the high school boy is not exposed to a program of training as strenuous as some might be lead to believe, since the cardiac response remains essentially unchanged during the season.

The change in the recovery pulse seems to indicate that the high school boys did derive some good by participating in the training program, since fewer heart beats were required to establish the resting level. Wherever a trend occurred, it favored the efficiency of the heart.

CONCLUSIONS

An investigation of the effects of a season of training and competition on the response of the hearts of high school boys justifies the following conclusions:

1. There was no significant change in the resting heart rate, pulse

rate immediately following exercise, rate above the resting rate after exercise and primary recovery time, and recovery time.

2. The recovery pulse was less after the season indicating that there was an improvement in physical condition as shown by the fact that fewer heart beats were required in reaching the resting level.

3. Wherever the data showed trends toward altered cardiac response, it was always in favor of more efficient heart action.

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A Factor and Validity Analysis of Strength Variables and Tests with a Test Combination of Chinning, Dipping, and Vertical Jump

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RESEARCH in strength test construction can be classified as, first, weighted strength variables predicting a criterion measure of motor ability and, second, weighted and unweighted variables predicting "total strength." The variables in the first classification are selected according to their "net" contribution to the criterion measure, whatever it might be. In the second classification the strengths of the various muscle groups are summed as either weighted or unweighted variables as an index of total strength of the musculature. Both of these accomplishments are tremendously valuable to workers in the field of health and physical education. Uses made of these combinations are well known, the former as a means of equalizing for athletic competition, the latter as an index of growth, development, and muscular fitness as well as a method of equalizing for competition. As a means of equalizing for athletic competition, however, the latter is not an efficient method.

A number of significant contributions have been made of the "weighted" strength variables as an index of motor ability. In these studies the conventional statistical methods are used to determine the "net" contribution of each variable to the criterion measure of motor ability. The criterion measure usually includes variables indicating the fundamental motor abilities of endurance, jumping, vaulting, throwing, speed, body coordination, body control, balance, agility, and sensory motor coordination. One of the real limitations of this method is the assumption that because endurance is one of the variables in this composite, the strength test finally selected measures endurance. One is likely to find that if endurance is eliminated from the composite the correlations will change but little, especially if the composite is made up of more than ten variables. The criterion measure has "general" meaning (levels of "total" motor achievement) and cannot be interpreted specifically (endurance, body coordination, agility, etc.). Significant contributions to this field are those by McCloy,[1, 2*] Cozens,[3] and Dun-

* The superior numbers throughout refer to the Bibliography at the end of this article.

der.[4] Minimum combinations have been proposed by these workers. McCloy's[1] combination consists of chinning and dipping strengths. This study verifies the significance of these variables.

In the form of "total strength" there are a number of well known contributions, both as "weighted" and "unweighted" variables making up an index of "total strength." The work of Kellogg[5] and that of Martin[6] are outstanding in the form of unweighted variables. These workers tested the various muscle groups to get an index of "total strength." Wendler's[7] work consisted of determining the minimum combination of strength variables to predict "total strength," and by statistically weighting the variables he found a correlation of .956 between six muscle groups and "total strength." "Total strength" was represented by a sum of the strengths of 47 muscle groups. Cozens found a correlation of .982 between five strength items and "total strength."[8] The criterion of total strength, however, was not as complete as the one used by Wendler. Rogers,[8] MacCurdy,[9] and McCloy[10] have proposed batteries of unweighted strength variables and have determined the validity of these as indices of "general" motor ability.

The contribution of this research is of the first classified strength tests (weighted strength variables as an index of motor ability), and no claim is made for the second (total strength). This should be kept in mind when using the test.

PURPOSE

This research has the following specific purposes:

1. To determine the components of the commonly used strength variables.

2. To determine how these "strength components" describe some of the strength tests now used in the field.

3. To determine how the "strength components" describe a composite motor ability criterion of fifteen items designed to measure approximately the following elements: endurance, body coordination, explosiveness, sensory motor coordination, jumping, speed and shiftiness, agility, body control, arm and shoulder girdle strength, abdominal strength, throwing, balance, and vaulting.

4. To construct a "best combination" of strength variables for the prediction of a criterion measure of motor ability.

5. To determine the relationship between age-height-weight and the constructed test.

6. To construct a classification device for the developed test.

LIMITATIONS

This study is limited, first, to one sample of college men. Springfield College students, of which the majority were major students in physical education, were used in the first experiment. The experiment, how-

ever, was repeated with another sample of Springfield College men and a sample of senior high school boys. Second, it is limited to the analysis of strength variables and tests as to their relationship to a criterion measure of motor ability and not components thereof. Third, it is limited to a selected number of strength variables which are items in the strength tests now used in the field.

METHOD

Experimental Method.—This experiment necessitated the administration of two groups of tests; the strength tests and the motor ability tests. These were administered to 160 Springfield College students within a one-week period (the entering freshman class of 1938.) The strength items used, along with the instruments and directions for administration, are found in Tables I and II. Following the administration of the tests, the index scores were calculated for the Rogers' Arm Strength,* Rogers' S.I.,† Rogers' P.F.I.‡ and the MacCurdy Physical Capacity Test.§ The fifteen motor ability scores were translated into standard scores and summed into a composite criterion.‖ The single strength variables, the strength tests, and the composite motor ability criterion made up the materials for the statistical analysis.

TABLE I

STRENGTH TESTS AND METHOD OF ADMINISTRATION

Strength Tests	Instrument or Equipment	Source for Directions of Administration
Right and left grips	Hand manometer	McCloy[10]
Back and leg strength	Back and leg dynamometer	McCloy[10]
Chinning	Horizontal bar	McCloy[10]
Dips	Parallel bars	McCloy[10]
Floor push-ups	None	Cozens (Table II)
Arm-pulling force	Dynamometer attached to gym. horse	MacCurdy[9]
Arm-pushing force	Same as arm-pulling force	MacCurdy[9]
Vertical jump	Blackboard on wall. Jump and reach method	MacCurdy[9]

Statistical Method.—The statistical analysis consisted of: first, the zero-order intercorrelations of all (16) variables and tests to be evaluated on the basis of a composite motor ability criterion;** second, the factor analysis[11] of the sixteen items to determine the minimum components; third, the development of the "best combination" of variables for the prediction of each factor using the rotated factor loadings as the zero-order criterion correlations in the multiple correlation com-

* Formula: $(C + D\ (W/10 + H - 60)$

† Sum of arm strength, right grip, left grip, back strength, leg strength, and vital capacity.

‡ The achieved S.I. divided by the norm for age and weight.

§ Sum of (right grip, left grip, back strength, leg strength, arm pulling force, arm pushing force) times (vertical jump) divided by 100.

‖ Tests: See Table II.

** Strength variables and tests: see Table IX.

TABLE II

MOTOR ABILITY TESTS AND METHOD OF ADMINISTRATION*

Motor Ability Tests	Instrument or Equipment†—Administration‡
Bar snap	Horizontal bar
Feet to bar	Horizontal bar
Half-lever	Horizontal bar
Bar vault	Horizontal bar
Rope climb	20-foot rope
Frog stand	Stop watch
Standing broad jump	Regulation track
Running broad jump	Regulation track
Standing hop-step-jump	Regulation track
Football punt for distance	Football
Football pass for distance	Football
Baseball throw for distance	Outseam playground ball
Shot-put	12-pound shot—regulation track
Dodging run	Five hurdles or similar objects
440-yard run	Running track

* See purpose (number 3) for fundamental motor abilities indicated by tests.
† Tape, stop watch are necessary for most tests.
‡ F. W. Cozens, *Achievement Scales in Physical Education Activities for College Men.* (Philadelphia: Lea and Febiger, 1938). This reference gives directions for all tests except "Feet to bar" and "half-lever on horizontal bar." Each is from a hanging position from the bar with feet close to bar in the first, and legs forming a right angle with the body in the second. Performance is recorded in seconds.

bination; and fourth, the determination of the "practical validity" of each equation used to predict each factor as an index of motor ability using the multiple correlation technique; fifth, the development of the "best combination" of strength variables* to predict the composite motor ability criterion using the multiple correlation technique.

RESULTS

Experiment One: Evaluation of Strength Variables and Tests—Development of a Test.—The first step was to correlate the strength items and tests with the criterion measure of motor ability (Table II: items in the criterion measure). The results of the zero-order correlations show that chinning, dips, and vertical jump items have higher correlations than those of the total "index scores" of the Rogers' S.I., Rogers' P.F.I., and the MacCurdy Physical Capacity Test (Table III).

In order to determine the maximum predictive value of the Rogers' S.I. for this sample, the items in the test were weighted through the use of the multiple correlation technique. The multiple correlation with the same composite motor ability criterion as was used for the evaluation of the items is .6628. This maximum correlation is not significantly different from that of the three items listed above: dips (.6337), chinning (.6803), and vertical jump (.6515). It was partly on the basis of these criterion correlations, partly on the basis of the factor analysis (Table IX), and partly on the basis of the "best combination" analysis (Table V) that these three variables were selected for the test. The combination of chinning, dips, and vertical jump (.8216) is not signifi-

* Vertical jump is one of the variables and serves as an index of explosiveness rather than pure strength.

cantly different from the combination of eight strength variable (.8505—Table V). The chinning and dips making up part of th Rogers' arm strength formula contributed approximately 90 per cen

TABLE III
ZERO-ORDER CORRELATIONS WITH THE COMPOSITE MOTOR ABILITY CRITERION*

Strength Variables and Tests	Zero-Order Correlations†
Leg strength	.3794
Back strength	.3724
Left grip	.3707
Right grip	.3484
Dips	.6337
Chinning	.6803
Floor push-ups	.5351
Arm-pulling force	.4666
Arm-pushing force	.3145
Vertical jump	.6515
Rogers' arm strength	.6419
Rogers' S.I.	.5916
MacCurdy physical capacity	.4803
Rogers' P.F.I	.5624
"Weighted" Rogers' S.I.	.6628

* Test Items in the criterion measure, Table II.
† The curvilinear correlations were calculated for the items in the constructed test. These a dips .6621, chinning .7420, and vertical jump .7270. These variables are slightly curvilin which reduces the predictive value from a higher multiple curvilinear correlation to the multip linear correlation of .8216.

TABLE IV
PERCENTAGE CONTRIBUTION OF THE ITEMS IN THE ROGERS' S.I. TO THE COMPOSITE MOTOR ABILITY CRITERION

Test Items	Percentage contribution to Composite Motor Ability Criterion
Arm strength	34.29
Right grip	0.42
Left grip	2.31
Leg strength	0.14
Back strength	0.77
Vital capacity	0.71
Total absolute contribution	38.64
R^2m (Direct and indirect contribution)	43.93
Percentage unmeasured	56.07

of the 38 per cent contribution of the "weighted" test in predicting th composite motor ability criterion (Table IV). The results of thi analysis (further evidence in factor analysis) show that chinning an dips represent the best strength variables of those selected for this stud and that these in combination with vertical jump give the best index The directions for the administration of this test and the method o scoring and classification are given under the section "administration

Experiment Two: Second Sample from Springfield College.—Th

TABLE V

MULTIPLE COMBINATION OF STRENGTH VARIABLES FOR THE PREDICTION OF THE COMPOSITE MOTOR ABILITY CRITERION

0 : Criterion of motor ability*	
1 : Dips	$R_{0.123589\ (10)\ (11)} = .8505$
2 : Chinning	$R_{0.1235\ (10)\ (11)} = .8485$
3 : Vertical jump	$R_{0.1235} = .8424$
4 : Floor push-ups	$R_{0.235} = .8302$
5 : Arm-pulling force	$R_{0.123} = .8216$
6 : Arm-pushing force	$R_{0.234} = .8176$
7 : Rogers' arm strength index	$R_{0.23} = .8038$
8 : Leg strength	$R_{0.37} = .7647$
9 : Back strength	
10 : Right grip	
11 : Left grip	

* Table II.

strength and motor ability tests were later administered to another group of Springfield College students (entering class of 1939). The motor ability criterion measure is the same as the one administered to the first group (class of 1938) with the exception of half-lever on the horizontal bar and the frog stand.* The zero-order correlations were calculated for the strength test items and the "index scores" of the Rogers' S.I., MacCurdy Physical Capacity Test, and the Springfield College Test. This procedure places these tests on a comparable basis, as the items in each are not statistically "weighted" according to their relationship to this criterion of motor ability. The Springfield College Test shows a slightly higher correlation (Table VI). The correlation for this test is lower (.6848) than that resulting from the sample used in its development (.8216). The first correlation, however, is "unweighted," the second statistically "weighted" in respect to the sample used.

TABLE VI

STRENGTH TESTS CORRELATED WITH CRITERION OF MOTOR ABILITY (UNWEIGHTED ITEMS)

Strength Tests	Zero-Order Correlations with Criterion
Rogers' S.I.	.5913
MacCurdy physical capacity test	.5206
Springfield College test	.6848

Experiment Three: Administration of Strength and Motor Ability Tests—Ballston Spa Senior High School Boys.—The strength and motor ability tests were administered to 187 senior high school boys of the Ballston Spa High School (in the fall, 1939).† [12] The purpose was to determine whether the findings of the college samples would

* Table II.

† Tables I and II for tests. The MacCurdy physical capacity test was not administered.

approximate the results from a sample of high school boys. It was felt that using a highly trained group of college men would produce different correlations for two reasons: first, because the age-height-weight correlations are lower in the college samples, and second, because the college men were highly trained in motor skills the inter-correlations might be quite different from those of the high school sample of boys with lesser ability, especially so if these correlations were cleared of the age-height-weight influence in the high school sample.

The statistical analysis of these data consisted of two parts: first, zero-order correlations of the strength variables and "index scores" of the strength tests with the criterion measure of motor ability, and second, the statistical "weighting" of each item on the basis of the zero-order correlations and placing these in a multiple correlation combination with the criterion measure. This was done with the purpose of securing the maximum relationship for this sample only.

The results of the correlations of the "index scores" of the strength tests were similar to those secured on the college data, with the exception of the Rogers' S.I., which showed a higher correlation in the high school data (Table VII). These correlations resulted from simply scoring each test and correlating this score with the composite motor ability criterion score.

TABLE VII
ZERO-ORDER CORRELATIONS OF STRENGTH TESTS WITH THE COMPOSITE MOTOR ABILITY CRITERION

Strength Tests	High School Data	College Data Sample One (1938)	College Data Sample Two (1939)
Rogers' S.I.	.8446	.5916	.5913
Rogers' P.F.I.	.5446	.5624	.3963
Springfield College test	.8353	*	.6848

* The Springfield College test was developed using this sample, therefore the test items are statistically weighted and the correlation is not comparable to those of the other tests. The "weighted" correlation is .8216.

The next step was to weight statistically each item in each of the three strength tests to determine the maximum correlation with the criterion. The results show a slight increase in the predictive value of the Springfield test, without any significant difference in the Rogers' S.I. (Table VIII).

TABLE VIII
STATISTICALLY WEIGHTED STRENGTH TESTS WITH CRITERION (HIGH SCHOOL DATA)

Strength Tests	Statistically Weighted Test	Total Score Correlation with Criterion-Unweighted Test
Rogers' S.I.	.8334	.8446
Springfield College M.E.T.	.8902	.8353

FACTOR ANALYSIS OF STRENGTH TESTS

After an inspection of the intercorrelations of the strength variables and tests, it appeared that these items were described by more than one component, that is, the strength variables seemed to cluster in two groups. Utilizing the Thurstone Factor Method,[11, 13] two distinct clusters were found (Table IX). The intercorrelations were completely described by these two factors (all reduced to within sampling error limits). It is very interesting to note that the significant correlations with factor one (arm strength—Rogers' formula, dips, chinning, floor push-ups, and vertical jump) all relate to the ability to lift the body weight or propel it upward, whereas the items which correlate high with factor two (leg strength, back strength, left and right grips, arm-pulling force, arm-pushing force) all relate to the ability to register strength on instruments without reference to the strength necessary to lift the body weight or propel it upward. In the first factor an increase in body mass may not add to one's ability as indicated by these variables as there is evidence to show that the relationship between increase in body mass and corresponding ability to handle it is not linear.* In the second factor, increase in body mass (especially if muscular tissue) will add to the ability to register this increase on instruments. In constructing strength tests as an index of motor ability it is the *first kind of strength* which it is desired to measure. Evidence following will substantiate this statement.

TABLE IX
ROTATED FACTOR LOADINGS

Strength Variables and Tests	Factor I	Factor II	h^2
Leg strength	.3194	*.6152*	.4805
Back strength	.2051	*.7120*	.5490
Left grip	.1442	*.7312*	.5555
Right grip	.0387	*.7632*	.5840
Dips	*.6886*	.3247	.5796
Chinning	*.7934*	.2020	.6703
Floor push-ups	*.5687*	.2543	.3881
Arm-pulling force	.2523	*.8389*	.7675
Arm-pushing force	.2200	*.5791*	.3838
Vertical jump	*.6184*	.1102	.3945
Tests			
Arm strength—Rogers	.6919	.5013	.7300
Rogers' S.I.	.7691	.2726	.6658
Rogers' P.F.I.	.7902	.0467	.6266
Springfield M.E.I.	.9383	.1296	.8972
MacCurdy P.C. index	.7189	.1082	.5285
C.M.A. criterion	.7907	.2938	.7115

Factor I is described as "dynamic strength," that is, strength applied to the ability to lift the body weight or propel it upward. Factor II is described as "static dynamometrical strength" or the ability to reg-

* Correlation between strength (Springfield Test) and weight is —.1728; curvilinear correlation is .3608.

ister on instruments the total strength power of the muscle groups tested. The question is: *When building strength tests, which of these two kinds of strength is the more significant as an indicator of motor ability?* This question is answered first by determining the "best combination of variables" to predict each of the two factors, and second, by determining the significance of each of these two combinations in terms of a fifteen variable composite index of motor ability.*

Using the factor loadings as zero-order correlations with the factor, the combination of dips, chinning, floor push-ups, and vertical jump gave a multiple correlation of .8827. Eliminating the floor push-ups because of the low percentage contribution, the correlation is .8817. Using the three selected variables (dips, chinning, and vertical jump) as Factor I (dynamic strength) and using the zero-order correlations of each of these three variables with the composite motor ability criterion as criterion correlations, the multiple correlation is .8216. Adding floor push-ups, the correlation is .8273. These correlations indicate the significance of dynamic strength as an index of (15-variable composite) motor ability.

The best combination of variables to predict Factor II is back strength, left grip, right grip, arm-pulling force, arm-pushing force. The multiple correlation is .9231. The first combination included the leg strength in addition, but it was dropped due to the low "net" contribution. The multiple correlation (with leg strength) is .9261. Using the same procedure as with Factor I (multiple correlation of items with composite motor ability criterion), the correlation is .4845, and with leg strength .4948. This indicates the significance of "static dynamometrical" strength as an index of motor ability (15-variable composite).

In summary, dynamic strength describes the composite motor ability criterion more completely (68 per cent) than does "static dynamometrical" strength (24 per cent). The point in this evidence is that strength registered by instruments may not be indicative of sufficient strength for effective control of body weight. It is not the instrumental strength which is desired as an index of motor ability, but whether or not there is sufficient strength effectively to control body weight. Effective control of body weight is fundamental in good large-muscle motor performances.

ADMINISTRATION OF TEST

Interpretation.—The distinguishing characteristics of the Springfield College Index are:

1. Strength ability is determined by the ability to lift the body weight and propel it upward. It is this ability that is important for

* Composite criterion items: See Table II.

successful performance of motor skills. The evidence in this research also indicates this to be true (.8216).

2. The strength items (chinning and dips) are not single, maximal efforts as registered on instruments, but muscular endurance tests using the body weight as the instrument, therefore they give a better index of muscle quality and in turn a better index of motor ability.

3. The vertical jump is a test of the ability to develop power in relation to the body weight. Strength in this item is not the major factor (.3069 between strength of legs and vertical jump) but the ability of the individual to utilize strength effectively in a force-time relationship.

The combination of the three items with the formula—power = force × velocity—was tried with the idea that this might increase the validity of the test. Using a sample of Springfield College men (150), the correlation for (C + D) × vertical jump is .6206, whereas when the items are "each" statistically weighted with the criterion measure of motor ability, the correlation is .8216. On the basis of this evidence the test was constructed with the sum of the weighted standard scores as the index score.

Directions for Administration of Test.—

1. Administration of Tests (ten-minute rest between dips and chinning).

a) *Chinning*: Use horizontal bar at such height that subject's feet do not touch the floor when subject is in lowered position. Subject can use either the forward or reverse grip. To begin, the subject hangs from the bar, then pulls himself up until his chin is over the bar. Then lowers himself until arms are straight. The subject is not permitted to kick, to swing, or to rest. Partial chins do not count. The count is one for each full chin.

b) *Dips*: The subject jumps to an arm rest position at the end of the parallel bars (bars at shoulder height), with arms fully extended. From this position the subject lowers his body to a right angle arm bend position and pushes up to the first position. The subject is not permitted to rest in any position, to swing, or to kick. Partial dips do not count. The count is one for the jump into the first position, then one for each full dip.

c) *Vertical Jump*: The preferred equipment for the measurement of the vertical jump is the MacCurdy Vertical Jump-meter.[9] If this equipment is not available, the well known jump and reach method is used. A blackboard of cloth is placed on the wall, high enough to record reach, and the best jump. The subject is asked to stand as close to the wall (face toward wall) as possible with both arms upstretched, with feet flat on the floor. A chalk mark is made of this maximum reach at tip of fingers for each hand. A line is then drawn between the two points. The subject then stands sideways with right or left arm close to the wall. Chalk dust is placed on the middle finger. The subject jumps recording height with the hand near the wall. The difference between maximum reach and maximum jump is recorded to the nearest half inch. The best one of three trials is selected.

2. Scoring and Classification. The steps in computing the index score are:

TABLE X

SCORING TABLE FOR CHINNING, DIPPING, AND VERTICAL JUMP
(COLLEGE MEN: 17–24)

Vertical Jump				Dips				Chinning			
Raw Score	Z Score	Std.* Score	Std. X2.27	Raw Score	Z Score	Std.* Score	Std. X 1.00	Raw Score	Z Score	Std.* Score	Std. X 1.00
26.0	3.561	100	227	30	4.237	109	109	30	5.686	130	276
25.8	3.483	99	225	29	4.034	106	106	29	5.422	126	267
25.6	3.405	98	222	28	3.831	104	104	28	5.158	122	259
25.4	3.327	97	220	27	3.628	101	101	27	4.894	119	252
25.2	3.249	95	216	26	3.425	98	98	26	4.630	115	244
25.0	3.171	94	213	25	3.222	95	95	25	4.366	111	235
24.8	3.093	93	211	24	3.019	92	92	24	4.102	107	227
24.6	3.015	92	209	23	2.816	89	89	23	3.838	104	220
24.4	2.937	91	207	22	2.613	87	87	22	3.574	100	212
24.2	2.859	90	204	21	2.410	84	84	21	3.310	96	204
24.0	2.781	89	202	20	2.207	81	81	20	3.046	93	197
23.8	2.703	88	200	19	2.004	78	78	19	2.782	89	189
23.6	2.625	87	197	18	1.801	75	75	18	2.518	85	180
23.4	2.547	86	195	17	1.598	72	72	17	2.254	82	174
23.2	2.469	85	193	16	1.395	70	70	16	1.990	78	165
23.0	2.391	83	188	15	1.192	67	67	15	1.726	74	157
22.8	2.313	82	186	14	.989	64	64	14	1.462	70	148
22.6	2.235	81	184	13	.786	61	61	13	1.198	67	142
22.4	2.157	80	182	12	.583	58	58	12	.934	63	134
22.2	2.079	79	179	11	.380	55	55	11	.670	59	125
22.0	2.001	78	177	10	.177	52	52	10	.406	56	119
21.8	1.923	77	175	9	−.026	50	50	9	.142	52	110
21.6	1.845	76	173	8	−.229	47	47	8	−.211	48	102
21.4	1.767	75	170	7	−.432	44	44	7	−.385	45	95
21.2	1.689	74	168	6	−.635	41	41	6	−.649	41	87
21.0	1.611	73	166	5	−.838	38	38	5	−.913	37	78
20.8	1.533	71	161	4	−1.041	35	35	4	−1.177	34	72
20.6	1.455	70	159	3	−1.244	33	33	3	−1.441	30	64
20.4	1.377	69	157	2	−1.447	30	30	2	−1.705	26	55
20.2	1.299	68	154	1	−1.650	27	27	1	−1.969	22	47
20.0	1.221	67	152		M=9.13				M=8.46		
19.8	1.143	66	150		σ=4.92				σ=3.79		
19.6	1.065	65	148								
19.4	.987	64	145								
19.2	.909	63	143								
19.0	.831	62	141								
18.8	.753	61	138								
18.6	.675	59	134								
18.4	.597	58	132								
18.2	.519	57	129								
18.0	.441	56	127								
17.8	.363	55	125								
17.6	.285	54	123								
17.4	.203	53	120								
17.2	.129	52	118								
17.0	.051	51	116								
16.8	−.027	50	114								
16.6	−.105	49	111								
16.4	−.183	47	107								
16.2	−.261	46	104								
16.0	−.339	45	102								
15.8	−.417	44	100								
15.6	−.495	43	98								
15.4	−.573	42	95								
15.2	−.651	41	93								
15.0	−.729	40	91								
14.8	−.807	39	89								

Vertical Jump (Continued)

Row Score	Z Score	Std. Score	Std. X2.27	Row Score	Z Score	Std. Score	Std. X2.27
14.6	−.885	38	86	11.0	−2.289	18	41
14.4	−.963	37	84	10.8	−2.367	17	39
14.2	−1.041	35	79	10.6	−2.445	16	36
14.0	−1.119	34	77	10.4	−2.523	15	34
13.8	−1.197	33	75	10.2	−2.601	14	32
13.6	−1.275	32	73	10.0	−2.679	12	27
13.4	−1.353	31	70	9.8	−2.757	11	25
13.2	−1.431	30	68	9.6	−2.835	10	23
13.0	−1.509	29	66	9.4	−2.913	9	20
12.8	−1.587	28	64	9.2	−2.991	8	18
12.6	−1.665	27	61	9.0	−3.069	7	16
12.4	−1.743	26	59	8.8	−3.147	6	14
12.2	−1.821	25	57	8.6	−3.225	5	11
12.0	−1.899	24	54	8.4	−3.303	4	9
11.8	−1.977	22	50	8.2	−3.381	3	7
11.6	−2.055	21	48	8.0	−3.459	2	5
11.4	−2.133	20	45		M=16.87		
11.2	−2.211	19	43		σ= 2.56		

* Standard Score = $\frac{14\,(x - m)}{\sigma} \times 50$

a) Change raw score into "weighted Standard Score:" Vertical Jump, Table X, column one; dips, Table X, column two; chinning, Table X, column three.

b) Sum "weighted Standard Scores." This is the "index score."

c) Determine classification (Table XI).

Illustration:

Test	*Raw Score*	*Weighted Std. Score*
Dips	10	52
Chinning	8	102
Vertical jump	14	77
Total Score		231

Classification: Poor

NORMS

Adequate strength norms represent a real need.[14] Weaknesses of the present strength norms are: (1) an "average" value is used as a norm rather than more finely divided statistical units; (2) the "total score" is normed and not each item in the test; and (3) all factors causing variation from subject to subject have not been evaluated. Age and weight are used, but there is evidence to show that skeletal build is also a significant consideration.[15, 16] Norms are not presented for the test in this publication. A *classification device* is presented which should not be considered a norm. An experiment is now in process, however, using this test, which takes cognizance of the three above-cited weaknesses and utilizes the graphic successive approximation method for each item to fit the regression lines according to the nature of the curvilinearity.[17]

Norms can be presented in two ways: first, by use of the regression equation and predicting what "should be" the strength for factors of age, height, weight, skeletal build, etc. This method necessitates a high enough multiple correlation between the factors and strength to reduce the standard error of estimate to a range which makes the "predicted score" or norm a meaningful value and not a wild statistical guess which is often interpreted as a "true" or "absolute" value. Second, norms can be constructed using groups homogeneous in respect to all factors which cause variations between subjects, then each of these homogeneous groups be described into as many statistical units as the reliability of the test will allow. This can range from one score (mean or median) to percentiles (rectangular distribution) or divisions based on sigma units (normal distribution). The second method of constructing norms is preferred, but presents difficulty if more than two constant factors are found.

In this research a classification device is presented for the college group (age 17–24) in the form of a five-point division (Table XI). The limitations of this device should be fully recognized. The method

does not take cognizance of the curvilinear correlations between age-height-weight and the Index for college data (Table XII).

TABLE XI

CLASSIFICATION

(COLLEGE MEN: 17–24)

Classification Scale			
Decile Values		Score Values and Classification Based on Sigma Units*	
		368–up	Excellent
90	356		
80	329		
70	309	309–367	Good
60	292		
50	277		
40	264		
30	250	249–308	Average
20	232		
10	200	190–248	Poor
		189–down	Very poor

$M = 278.98$
$\sigma = 59.60$
$N = 309$

* Percentage of scores in each classification:
Excellent = 6.45 (1.5σ)
Good = 24.17 (1.0σ)
Average = 38.30 (1.0σ)
Poor = 24.17 (1.0σ)
Very poor = 6.45 (1.5σ)

TABLE XII

AGE-HEIGHT-WEIGHT CORRELATIONS WITH SPRINGFIELD* TEST (TOTAL SCORE)

	High School and College Data $N = 973$ (age 12–26)	College Data $N = 309$ (age 17–24)
Age	$r = .4959$ *eta* $= .5992$	$r = .0234$ *eta* $= .2147$
Height	$r = .4550$ *eta* $= .5046$	$r = .1728$ *eta* $= .3608$
Weight	$r = .4139$ *eta* $= .5515$	$r = .0601$ *eta* $= .2260$

* The rectilinear age-height-weight correlations (college data) for chinning, dips, and vertical jump (Springfield test) range from —.2573 to .0546. ($N = 309$). These data are curvilinear, therefore, norms must be constructed according to the nature of the curvilinear relationship.

These correlations are not high but significant. Their combined effect on "classification" would, of course, be higher than the highest zero-order correlation (.3608). This means that the tall-heavy-older boys will tend to have slightly higher scores, and the short-slender-

younger boys slightly lower. This effect, however, is not serious as far as a *classification device* is concerned, as it is not desired to know what "should be" the strength development but to simply place people together that fall into the same classification in "muscular efficiency" in order to have homogeneous groups. The weakness of the device is mechanical (height, in some activities). This classification device can be made to serve a useful purpose as a method of equalizing for activity participation. It does not indicate what "should be" one's strength development as this must be determined by such constant factors as age, height, weight, skeletal build, etc.

In a preliminary norm study, using the total index score for the Springfield Test, the multiple correlation between age-height-weight and the test was .5050; the multiple curvilinear correlation, .6427. The age range for this experiment was 14 to 26, using the 366 subjects.[18] Further work with 973 subjects with an age range from 12 to 26 seems to indicate that a better fitting curve can be secured by separating college and high school data. Rectilinear correlations between skeletal measures and strength for the college group are all low. A later publication will present norms for this test.

CONCLUSIONS

1. The factor analysis of the strength items resulted in two components: dynamic strength, or strength determined by the ability to lift the body weight and propel it upward, and static dynamometrical strength, or strength determined by the ability to squeeze, push, pull, or lift as registered on the dynamometer.

2. Dynamic strength is nearly three times more significant in predicting a composite index of motor ability than is static dynamometrical strength. The first describes a composite motor ability criterion to the extent of 68 per cent, the latter 24 per cent.

3. The strength test developed in this research (dips, chinning, and vertical jump) utilizes the elements of dynamic strength, therefore it yields a higher validity correlation, as compared to the other strength tests, with the criterion measure of motor ability.

4. Arm strength as indicated by the Rogers' formula contributes approximately 90 per cent of the total 38 per cent of the composite motor ability criterion described by the Rogers' S.I. The elements of the arm strength (chinning and dips) are dynamic strength elements.

5. The Index developed in this research, and the Rogers' S.I., are equally significant for high school boys. The chief contribution of the Rogers' S.I. is again due to arm strength (chinning and dips).

The writer wishes to acknowledge help given in the statistical computations by Mr. Herleik Quamme, Graduate Assistant in Tests and Measurements.

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The Organization and Administration of Health and Physical Education in Large Cities

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ADMINISTRATORS of public school systems, as well as those who direct the programs of health and physical education, want facts concerning the organization and administration of these programs in many school systems. During the school year of 1939-1940, the writer needed facts concerning the organization and administration of the departments of health and physical education in cities over one hundred thousand in population. Sixty-four cities were selected in various parts of the United States, and only three of these had a population of less than one hundred thousand. These three smaller cities were chosen because of their geographical location and significance to the survey being attempted. Fifty-one cities replied in time to be included in this summary.

The questions were worded as far as possible so that the answer would be based on facts rather than on opinion. No claims are made that this material comprises scientific research, but it is offered for what it is worth from the standpoint of actual practice in the larger cities in 1939-40.

Cities Replying to Questionnaire on Organization and Administration

City	*Population*	*City*	*Population*
Atlanta, Georgia	360,691	Grand Rapids, Michigan	168,592
Baltimore, Maryland	804,874	Hartford, Connecticut	164,072
Birmingham, Alabama	259,678	Houston, Texas	292,352
Buffalo, New York	573,678	Indianapolis, Indiana	364,161
Chicago, Illinois	3,376,438	Jersey City, New Jersey	316,715
Cincinnati, Ohio	451,160	Kansas City, Kansas	121,857
Cleveland, Ohio	900,000	Lincoln, Nebraska	79,592
Dallas, Texas	260,475	Long Beach, California	142,032
Dayton, Ohio	200,982	Los Angeles, California	1,238,048
Denver, Colorado	287,861	Louisville, Kentucky	307,745
Des Moines, Iowa	142,559	Miami, Florida	110,637
Detroit, Michigan	1,568,662	Minneapolis, Minnesota	464,356
Duluth, Minnesota	101,463	Newark, New Jersey	442,337
Evansville, Indiana	102,249	New Orleans, Louisiana	458,762
Fort Worth, Texas	163,447	Oakland, California	284,063

Oklahoma City, Oklahoma	185,389	San Francisco, Cal.	634,394
Omaha, Nebraska	214,006	Seattle, Washington	365,583
Peoria, Illinois	104,969	Sioux City, Iowa	79,183
Philadelphia, Pa.	1,950,961	Spokane, Washington	115,514
Portland, Oregon	301,815	Springfield, Mass.	149,900
Providence, R.I.	252,981	Syracuse, New York	209,326
St. Joseph, Missouri	80,935	Toledo, Ohio	290,718
St. Louis, Missouri	821,960	Tulsa, Oklahoma	141,258
St. Paul, Minnesota	271,606	Washington, D.C.	486,869
Salt Lake City, Utah	140,267	Wichita, Kansas	111,110
San Antonio, Texas	231,542		

SUMMARY OF QUESTIONNAIRE

A. General

1. Is there a Department of Health and Physical Education in your schools? Yes, 51.

2. Is the Division of Health administered separately from Physical Education? Yes, 36; No, 14; No answer, 1. Or is it a unit of a larger department such as:

a) Department of Health and Physical Education? Yes, 12.

b) One of many divisions under an administrative coordinator? Yes, 5.

c) Under whose control? Board of Education, 35; City Board of Health, 5; Cooperating city and schools, 11.

3. Under whose immediate direction do school nurses work?

a) Supervisor of school nurses? 20.

b) School Physician? 12.

c) Director of Health and Physical Education? 4.

d) City Board of Health? 14; No nurses employed, 1.

4. Is there a city-wide health council and is the school health department a part of it? Yes, 15; No, 32; No answer, 4.

5. If the school nurses are employed by the Board of Health, would a change to the direction of the Board of Education be desirable, provided funds were available? Yes, 39; No, 6; No answer, 5; No nurses employed, 1.

6. Is the Department of Health and Physical Education organized in divisions as follows:

a) Health Service, Health Instruction, Physical Education, Recreation? 5.

b) Health Service, Health Instruction, Physical Education? 4.

c) Health and Physical Education? 3.

d) Health separated from Physical Education? 36.

e) Other combinations? 1.

f) No answer, 2.

7. Is there a Director or Supervisor of Health and Physical Education? Yes, 17; No, 34; Director of Health, 27; Director of Physical Education, 28.

8. What is the annual salary of the Director of Health and Physical Education? $2,640 to $8,000.

a) What is the annual salary of the Director of Health? $2,000 to $6,500.

b) What is the annual salary of the Director of Physical Education? $2,100 to $7,500.

9. What qualifications does the Director have?

a) Academic degrees? Many combinations of degrees.

b) Experience? Range 10 years to 38 years.

10. Is there an Assistant Director or Supervisor of Health and Physical Education? Yes, 7; Assistant Director of Health, 7; Assistant Director of Physical Education, 9; Total, 23.

11. What is the annual salary of the Assistant Director? $2,300 to $5,000.

a) Assistant Director of Health? $2,525 to $4,600.

b) Assistant Director of Physical Education? $1,800 to $5,100.

12. What qualifications does the Assistant Director have?

a) Academic degrees? Many combinations of degrees.

b) Experience? 14 to 25 years.

13. Is there a Supervisor of each division in the organization, such as:

a) Supervisor of Health Service? Yes, 5; No, 8; Director acts as supervisor in 38 cities.

b) Supervisor of Health Instruction? Yes, 4; No, 10; Director acts as supervisor in 37 cities.

c) Supervisor of Physical Education? Yes, 11; No, 5; Director acts as supervisor in 35 cities.

d) Supervisor of Recreation? Yes, 6; No, 7; Director acts as supervisor in 38 cities.

14. Are the above division supervisors responsible to the Director of the Department? Yes, 17; No, 9; No answer, 25.

15. What is the annual salary of the:

a) Supervisor of Health Service? $2,400 to $4,200.

b) Supervisor of Nurses? $1,500 to $4,500.

c) Supervisor of Health Instruction? $2,750 to $4,550.

d) Supervisor of Physical Education? $2,300 to $4,000.

e) Supervisor of Recreation? $1,960 to $4,435.

16. What qualifications such as academic degrees, experience, other, are held by the following:

a) Supervisor of Health Service? R.N., B.S., M.A.—1; M.D.—12; M.A.—2; A.B., M.D.—4; A.B.—1; M.D., C.P.H.—2; B.S., M.D., M.P.H., D.D.S.—1. Number years of experience? 4 to 36 years.

b) Supervisor of Nurses? R.N.—8; A.B., P.H.N.—1; M.A.—1; M.S.—2. Number years of experience? 8 to 31 years.

c) Supervisor of Health Instruction? A.B., Sc.D.—1; Ph.D.—1; M.A.—2; M.S.—2; B.A., M.S.—2; B.S., M.S.—1; B.S., M.A.—1; A.B., A.M.—1. Number years of experience? 11 to 30 years.

d) Supervisor of Physical Education? B.P.E.—1; B.S., B.P.E.—2; A.B.—3; A.M.—7; B.S.—1; A.B., A.M.—2; M.S.—1; B.S., A.M.—1 Number years of experience? 2 to 30 years.

e) Supervisor of Recreation? B.S.—1; A.B.—1; B.P.E.—1; A.M.—1. Number years of experience? 10 to 28 years.

17. Are there Assistant Supervisors in:

a) Health Service? Yes, 9; No, 27; No answer, 15.

b) Health Instruction? Yes, 7; No, 29; No answer, 15.

c) Physical Education? Yes, 13; No, 23; No answer, 15.

18. Does the Board of Education provide supplies such as cotton, bandage, tape, balls, bats, nets, etc., used by the schools? Yes, 45; No, 4; No answer, 2.

19. How is the budget set up:
a) By the individual schools? 8.
b) By the Health and Physical Education Department? 23.
c) Others? 18.
d) No answer, 2.

B. HEALTH SERVICE

Physician.—

1. Is there a full-time physician? Yes, 29; No, 22.

2. Is there more than one full-time physician? Yes, 13; No, 28; No answer, 10.

3. What is the annual salary of the physician?
a) Full-time, $2,000 to $6,500.
b) Part-time, $1,200 to $4,600.

4. What educational qualifications are required of the school physician before electing him?
a) Graduate in medicine plus internship? Yes, 36; No answer, 15.
b) Degree in Public Health? Yes, 2; No, 4; No answer, 45.
c) Special courses such as:
(1) Community health problems? Yes, 8; No, 1; No answer, 42.
(2) School medical problems? Yes, 6; No, 1; No answer, 44.
(3) Public health administration? Yes, 3; No, 1; No answer, 47.
(4) Mental hygiene? Yes, 3; No, 1; No answer, 47.
(5) Physiology, child growth and development? Yes, 4; No, 1; No answer, 46.
(6) School sanitation, epidemiology? Yes, 4; No, 1; No answer, 46.
(7) Pediatrics? Yes, 4; No, 1; No answer, 46.
(8) Psychology of education? Yes, 3; No, 2; No answer, 46.
(9) Health statistics? Yes, 4; No, 2; No answer, 45.
(10) School administration? Yes, 3; No, 2; No answer, 46.
(11) Principles of physical education? Yes, 2; No, 3; No answer, 46.
(12) Principles of teaching? Methods and materials in health education? Yes, 3; No, 2; No answer, 46.

5. Are there part-time school physicians? Yes, 42; No, 7; No answer, 2.

6. How are part-time physicians paid? Hour, 7; Day, 4; Year, 25; Month, 6; No answer, 9.

7. How much is paid part-time physicians? Hour, $2 to $5; Half-day, $4 to $6; Year, $50 to $3,180; Month, $50 to $334.

8. If there is a full-time physician does he head up the division of Health Service? Yes, 30; No, 3; No answer, 18.

9. Are all pupils examined by a school physician? Yes, 7; No, 40; No answer, 4.

10. If an annual examination is not given by a school physician to all pupils, what grades are examined? Kindergarten, 24; First, 23; Second, 7; Third, 15; Fourth, 14; Fifth, 10; Sixth, 11; Seventh, 19; Eighth, 11; Ninth, 17; Tenth, 10; Eleventh, 3; Twelfth, 5; Athletes, 5; No answer, 14.

11. Is an examination by the family physician accepted in lieu of one by a school physician? Yes, 27; No, 18; No answer, 6.

Dentist.—

12. Is there a full-time school dentist? Yes, 13; No, 37; No answer, 1.

13. Is there more than one full-time dentist? Yes, 7; No, 25; No answer, 19.

14. What is the annual salary of the dentist?

a) Full-time, $1,400 to $5,000.

b) Part-time, $ 600 to $2,000.

15. Are there part-time dentists? Yes, 27; No, 16; No answer, 8.

16. Are the part-time dentists paid by: Hour, 3; Day, 3; Year, 20; Month, 3; No answer, 21.

17. How much is paid part-time dentists? Hour, $2.00; Day, $4.90 to $6.67; Year, $150 to $3,340; Month, $85 to $125.

18. Are all pupils examined annually by a school dentist? Yes, 9; No, 33; No answer, 9.

19. If an annual examination is not given to each pupil by a dentist, what grades are examined? About the same as for medical examinations. See No. 10 above.

20. Is an examination by the family dentist accepted in lieu of an examination by a school dentist? Yes, 26; No, 11; No answer, 14.

Nurse.—

21. Is there a Supervisor of Nurses? Yes, 39; No, 11; No answer, 1.

22. Is there more than one Supervisor of Nurses? Yes, 11; No, 30; No answer, 10.

23. What are her qualifications?

a) Academic? Wide range and many combinations of degrees.

b) Experience? 2 to 25 years.

24. What is the salary range for a Supervisor of Nurses?

a) Minimum? $900.

b) Maximum? $4,600.

25. How many school nurses employed?

a) By whom?

(1) Board of Education? 36.

(2) Board of Health? 4.

(3) Jointly? 11.

26. What educational qualifications are required of a school nurse before electing her?

a) Graduate from an accredited school of nursing? 46.

b) Special courses in public health education? 25.

c) Certification in public health? 13.

d) College graduate with major in public health or health education? 7.

e) One year of public health or school nursing experience? 10.

f) Any other requirements—please add. 7.

27. What are the special qualifications for elementary school nurses? None. (See No. 26.)

28. What are the special qualifications for high school nurses? None. (See No. 26.)

29. Does the pupil load vary for different type of neighborhood—industrial, well-to-do? Yes, 28; No, 12; No answer, 11.

30. Between what ages are school nurses employed? 18 to 65 years.

31. Of what does a school nurse's work consist:

a) Inspection of individuals and groups? Yes, 46; No, 1; No answer, 4.

b) Home calls? Yes, 45; No, 2; No answer, 4.

c) Teaching? Yes, 27; No, 6; No answer, 18.

d) Talks to adult groups? Yes, 40; No, 1; No answer, 10.

e) First aid and dispensary work? Yes, 39; No, 1; No answer, 11.

f) Truancy calls? Yes, 6; No, 19; No answer, 26.

32. Is there a nurse in each high school? Yes, 28; No, 19; No answer, 4.

33. What is the salary range for school nurses? $900 to $3,100.

34. Are high school nurses on a higher salary scale than the elementary nurses? Yes, 3; No, 37; No answer, 11.

35. Is there a salary increase for more academic preparation? Yes, 11; No, 32; No answer, 8.

36. Are the duties of high school nurses combined with counseling? Yes, 15; No, 26; No answer, 10.

37. If funds are available, would it be advantageous to the school system to employ more school nurses? Yes, 42; No, 5; No answer, 4.

38. Is there a school nursing manual. Yes, 22; No, 21; No answer, 8. Prepared by whom? Director, supervisors, and staff, 17; N.O.P.H.N., 1; State and local health department, 2; Educational director, 1.

39. Is there a program of in-service training for nurses?

a) Demonstrations? Yes, 25; No, 10; No answer, 16. Two a month, 2; One a month, 8; Weekly, 6; Four a year, 1.

b) Small group meetings? Yes, 27; No, 3; No answer, 21. Monthly, 1; Weekly, 3; When needed, 3.

c) Entire staff? Yes, 35; No, 2; No answer, 14. Daily, 1; Weekly, 2; Two a month, 2; One a month, 7; Occasionally, 2.

40. Does the school nurse help the classroom teacher with health instruction? Yes, 33; No, 13; No answer, 5; Advisory, only 14 cities specified.

41. Does the school nursing program give any service to the preschool child? Yes, 33; No, 14; No answer, 4.

42. If so, how much? Summer Round-up P.-T.A., 17; Clinics, 1; Examined by School Doctor in May.

43. If not, what other community facilities care for the pre-school child? City Health Department and Visiting Nurse Association, 20; P.-T.A., 4; Board of Education Preschool Clinic, 1; Red Cross, 1; W.P.A., 1.

44. Is there a school medical advisory committee composed of members of your local county medical society? Yes, 18; No, 26; No answer, 7.

45. If so, what is the relationship to the department? Advisory, 16.

46. Do you have pre-kindergarten examinations conducted by the Parent-Teacher Association summer round-up plan? Yes, 40; No, 8; No answer, 3.

Clinics.—

47. Is there a school dental clinic? Yes, 30; No, 18; No answer, 3.

48. Are children expected to pay for each sitting? Yes, 5; No. 26; No answer, 20. How much? One, 10c; One, 25c; One, 50c; One, 25c to 75c.

49. Is there a school clinic or clinics for:

a) Orthopedic defects? Yes, 16; No, 29; No answer, 6.

b) Visual defects? Yes, 23; No, 13; No answer, 15.

c) Hearing defects? Yes, 24; No, 12; No answer, 15.

d) Speech defects? Yes, 21; No, 15; No answer, 15.

e) Respiratory, cardiac, nutritional defects? Yes, 23; No, 12; No answer, 16.

50. Are children expected to pay for each visit to the clinic? Yes, 2; No, 30; No answer, 19.

Special Rooms.—

51. Does the Division of Health Service include the work of:
a) Special rooms? Yes, 23; No, 19; No answer, 9.
b) Visiting teachers? Yes, 9; No, 24; No answer, 18.
c) Psychiatrists and psychologists? Yes, 14; No, 20; No answer, 17.

52. Do you have special schools or rooms for handicapped children in your schools?
a) Sight saving? Yes, 35; No, 7; No answer, 9.
b) Hard of hearing? Yes, 36; No, 7; No answer, 8.
c) Crippled? Yes, 34; No, 7; No answer, 10.
d) Open-window room for:
(1) Cardiac? Yes, 21; No, 14; No answer, 16.
(2) Asthma? Yes, 13; No, 13; No answer, 25.
(3) Tuberculosis contacts? Yes, 19; No. 13; No answer, 19.

53. Are these special schools or rooms under the direction of the Department of Health and Physical Education? Yes, 18; No, 26; No answer, 7.

54. If not, what department does give direction to these rooms? Special Education, 10; Superintendent of Schools, 3; Elementary Education, 3; Individual Guidance, 1; Social Service, 1; City Health Department, 1; Local Medical Society, 1.

55. What is the average pupil load in a special room? Lowest, 8; Highest, 40; Preference, 15 to 25.

56. What per cent of the total school enrollment is in these special rooms? Less than 1, 5; 1 to 1.9, 6; 2 to 2.9, 7; Others 3, 4, 5, 6, 7, and 11 per cent, 1 each.

57. Are all the handicapped children in special schools? Yes, 8; No, 34; No answer, 9.

58. If not, why?
a) Lack of finances.
b) Limited number of rooms.
c) Transportation.
d) Not financially, psychologically, educationally, or socially sound.
e) To avoid creating complexes in those who can carry on.
f) Some in regular rooms doing regular work.
g) Parents object.
h) Some in homes and hospitals taught by itinerant teacher.
i) Lack of knowledge about rooms.
j) School system not large enough.
k) No provision made for them.

59. What objections are given by parents in not sending handicapped children to special schools or rooms?
a) My child isn't dumb.
b) Distance from home—transportation.
c) Stigma of being different; inferiority complex.
d) Lack of knowledge on parent's part concerning room.
e) Child would never get to high school.
f) Do not want their children segregated.

60. How many grades are grouped in a special room? Three grades, 10; Six grades, 6; Two grades, 3; Four grades, 2; One grade, 2.

C. Health Instruction

1. Does the elementary classroom teacher give health instruction? Yes, 45; No, 2; No answer, 4.

2. Is this health instruction given incidentally? Yes, 26; No, 16; No answer, 9.

3. Is this health instruction given specifically? Yes, 36; No, 4; No answer, 11. How often? Once a week, 12; Twice a week, 9; Three a week, 1; Daily, 6.

4. Is there a course of study in health instruction for elementary school? Yes, 35; No, 12; No answer, 4.

5. Who prepared it? Principals and teachers, or committee, 21; State adopted, 3; Supervisory department, 12.

6. Who teaches health in the junior high school? Physical education teachers, 23; Classroom teachers, 5; Science teachers, 5; Special teachers, 3; Home economics, 2; Nurse, 2; Health Counselor, 1.

7. How often? Once a week, 15; Twice a week, 8; Three a week, 2; Daily, 5; Once a month, 1; Once every two weeks, 1.

8. Is there a course of study in health for junior high school? Yes, 33; No, 9; No answer, 9.

9. Who prepared it? Committee, 20; State adopted, 2; Supervisory department, 10.

10. Who teaches health in the senior high school? Physical education teachers, 31; Biology, 1; Classroom teacher, 6; Special teacher, 5; Science teacher, 4; Home economics, 3; Nurse, 1; Health Counselor, 1.

11. How often? Once a week, 24; Twice a week, 6; Three a week, 1; Daily, 4.

12. Is there a course of study in health for senior high schools? Yes, 27; No, 16; No answer, 8.

13. Who prepared it? Committee, 17; State adopted, 1; Supervisory department, 10.

14. Are supplementary health readers or texts available in the elementary schools? Yes, 43; No, 1; No answer, 7. Junior high? Yes, 40; No answer, 11. Senior high? Yes, 38; No, 1; No answer, 12.

15. Are health charts, models, diagrams, etc., available in the elementary schools? Yes, 32; No, 3; No answer, 16. Junior high? Yes, 34; No, 2; No answer, 15. Senior high? Yes, 35; No. 3; No answer, 13.

D. Physical Education

1. Is there an intramural program of athletics for the junior high? Yes, 42; No, 5; No answer, 4. Senior high school? Yes, 47; No, 1; No answer, 3.

2. Does the intramural program provide for girls? Yes, 47; No, 1; No answer, 3. Boys? Yes, 49; No answer, 2.

3. Is there an interscholastic program of athletics for the junior high? Yes, 18; No, 31; No answer, 2. Senior high school? Yes, 49; No answer, 2.

4. Do girls participate in interscholastic athletics in junior high? Yes, 5; No. 38; No answer, 8. Senior High? Yes, 7; No. 41; No answer, 3.

5. Are interscholastic athletics under the supervision of:

a) Director or supervisor of physical education? 17.
b) Head of the department of physical education in each school? 1.
c) Coach? 1.
d) Principal? 2.
e) Combinations of above? 28.
f) No answer, 2.

6. Are the high school teams coached by an academic teacher? Yes, 28; No, 21; No answer, 2.

7. Are high school teams coached by a physical education instructor? Yes, 45; No, 3; No answer, 3. In 24 cities both academic and physical education teachers are used.

8. If an academic teacher does the coaching, is he considered a part of the health and physical education department? Yes, 22; No, 13; No answer, 16.

9. Do you have a physical education course of study for:
a) Primary grades (1, 2, 3)? Yes, 45; No, 3; No answer, 3.
b) Intermediate grades (4, 5, 6)? Yes, 46; No, 2; No answer, 3.

10. Do the classroom instructors teach physical education in the:
a) Primary grades (1, 2, 3)? Yes, 41; No, 2; No answer, 2; Special teacher, 6.
b) Intermediate grades (4, 5, 6)? Yes, 29; No, 7; No answer, 4; Special teacher, 11.

11. If the classroom instructors teach physical education in the elementary grades (1 to 6) how often are they given supervisory help? On call, 15; Once a month, 7; Once each six weeks, 6; Four times a year, 4; Once a year, 2; Once a week, 2; Twice a year, 1; Twice a month, 1.

12. If classroom instructors do not teach physical education in the elementary schools, is there a physical education specialist who teaches? Yes, 21; No, 4; No answer, 26.

13. How often does she come to the school? Daily, 12; Twice a week, 2; Three times a week, 1; Occasionally, 1.

14. How many classes per day does she teach? 12 classes, 6; 6 classes, 6; 10 classes, 5; 8 classes, 2; 18 classes, 2.

15. What is the average number of pupils which she has in each class? 40 pupils, 7; 35 pupils, 7; 60 pupils, 2; 50 pupils, 2; 45 pupils, 1; 30 pupils, 1.

16. What is the average length of each physical education period in:
a) Primary Grades (1, 2, 3) 20 minutes, 17; 30 minutes, 16; 15 minutes, 8; 25 minutes, 2; 40 minutes, 2; 45 minutes, 1; 1 hour, 1.
b) Intermediate Grades (4, 5, 6) 30 minutes, 17; 45 minutes, 8; 20 minutes, 7; 25 minutes, 4; 40 minutes, 4; 15 minutes, 2; 50 minutes, 2; 35 minutes, 1; 1 hour, 1.

17. Is the physical education time allotment in addition to the recess period? Yes, 43; No, 5; No answer, 3.

18. How long are the recess periods in the elementary schools (1–6)? 15 minutes, 23; 20 minutes, 11; 10 minutes, 6; 5 minutes, 2; 30 minutes, 2.

19. Do primary (1, 2, 3) and intermediate (4, 5, 6) grades have recess at the same time? Yes, 7; No, 15; Varies, 26; No answer, 3.

20. Do you have the following activities in your elementary (1-6) physical education program?

a) Rhythmical? Yes, 46; No, 5.
b) Self-testing (apparatus-stunts)? Yes, 41; No, 10.
c) Games? Yes, 47; No answer, 4.
d) Calisthenics? Yes, 33; No, 7; No answer, 11.
e) Athletic games of low organization? Yes, 48; No answer, 3.

21. Are provisions made for improving the in-service training for:
a) Classroom teacher? Yes, 39; No, 2; No answer, 10.
b) Physical education teacher? Yes, 39; No, 2; No answer, 10.
c) What is the most satisfactory plan of training? Demonstrations, 16; Staff meetings, 15; Supervisory visits and conferences, 14; Curriculum construction, 2; Bulletins, 5; University courses, 2; Visiting days, 1.

22. Is the playground and gymnasium equipment kept in a common box which all students use? 22. Or is it divided among the rooms? 6. Both common box and room? 20. No answer, 3.

23. Are children permitted to go on the gymnasium floor wearing street shoes? Yes, 15; No, 33; No answer, 3.

24. Do girls in the elementary grades (1–6) wear the following gymnasium costume:
a) Waist? Slacks? Shorts? Gymnasium shoes? 1.
b) One piece bloomer suit? One piece short and skirt suit? Gymnasium shoes? 9.
c) None required? Street (school) clothes? 33.
d) Gymnasium shoes? 1.
e) No answer, 2.

25. Do boys in the elementary grades (1–6) wear sleeveless jerseys and shorts in the gymnasium classes? Yes, 6; No, 31; Varies, 9; No answer, 5.

26. Is the playground equipment provided for elementary schools (1–6) included in the physical education department budget? Yes, 29; No, 15; No answer, 7. Gymnasium equipment? Yes, 28; No, 13; No answer, 10.

27. Is such equipment provided in some other budget? Yes, 10; No, 16; No answer, 25.

28. What is composition of playgrounds of the elementary schools (1–6)? Gravel, 32; Brick, 7; Dirt, 27; Asphalt, 25; Grass, 24.

29. How many square feet of play space is provided for each elementary school (1–6)? Varies greatly, 30,000 sq. ft., 1; 40,000 sq. ft., 3; 50,000 sq. ft., 1; 60,000 sq. ft., 2; 75,000 sq. ft., 1; 100,000 sq. ft., 1; Over 400,000 sq. ft., 2; 3–10 acres, 6.

30. Do you have a physical education course of study for:
a) Junior high school? Yes, 39; No, 4; No answer, 8.
b) Senior high school? Yes, 41; No, 7; No answer, 3.

31. What is the average number of pupils in each class:
a) Junior high school? 30 pupils, 1; 35 pupils, 1; 38 pupils, 1; 40 pupils, 7; 45 pupils, 6; 48 pupils, 1; 50 pupils, 7; 55 pupils, 1; 60 pupils, 5; 65 pupils, 2; 70 pupils, 1; 80 pupils, 3; 100 pupils, 3.
b) Senior high school? 35 pupils, 1; 40 pupils, 6; 45 pupils, 4; 50 pupils, 12; 85 pupils, 1; 90 pupils, 3; 100 pupils or over, 2.

32. Do the girls in the physical education classes wear:
a) One piece bloomer suit? 23.
b) Shorts or one piece short-skirt? 14.
c) Varies—any style? 11.

d) No answer, 3.

e) (Outdoors) Sweat pants? Sweat shirt? Yes, 16; No, 12; Optional, 2; No answer, 20.

33. Do the boys in the physical education classes wear:

a) Sleeveless white jerseys? Yes, 37; Anything, 3; Choice of color, 4; No answer, 7.

b) White shorts? Yes, 29; Anything, 2; Choice of color, 14; No answer, 6.

c) Gymnasium shoes? Yes, 45; No, 6.

34. Do the junior and senior high school girls wear colored bathing suits? Yes, 6; No, 16; No pools, 18; No answer, 11; Mostly gray tank suits used.

35. How many times per week are the girls scheduled to swim? Once a week, 9; Twice a week, 7; Three times a week, 1; Daily, 1; Others did not reply.

36. How many times per week are the boys scheduled to swim? Once a week, 8; Twice a week, 7; Three times a week, 1; Four times a week, 1; Daily, 1.

37. Are the recommendations suggested in the *Physical Education Curriculum* (A National Program by Wm. R. LaPorte) being followed: Yes, 29; No, 9; No answer, 13.

38. How many square feet of hard surfaced play space is available in the:

a) Junior high schools? Varies—1,500 sq. ft. to 495,000 sq. ft.

b) Senior high schools? Varies—4,000 sq. ft. to 495,000 sq. ft.

39. How many square feet are in the play fields, including hard surface but exclusive of the athletic field, of the:

a) Junior high schools? Varies—40,000 sq. ft. to 1,023,206 sq. ft.

b) Senior high schools? Varies—5,000 sq. ft. to 2,265,120 sq. ft.

40. How many square feet do you have in the athletic fields of the:

a) Junior high schools? Varies from 40,000 sq. ft. to 217,800 sq. ft.

b) Senior high schools? Varies from 87,000 sq. ft. to 3,490,000 sq. ft.—88 A.

41. Are corecreation classes conducted during school hours?

a) Junior high school? Yes, 27; No, 14; No answer, 10.

b) Senior high school? Yes, 27; No, 14; No answer, 10.

42. Do you have corecreation classes after school hours?

a) Junior high school? Yes, 26; No, 10; No answer, 15.

b) Senior high school? Yes, 30; No, 10; No answer, 11.

43. Do you have coeducational swimming classes as part of the physical education program:

a) Junior high school? Yes, 1; No, 27; No pool, 7; No answer, 16.

b) Senior high school? Yes, 10; No, 19; No pool, 6; No answer, 16.

44. Do you have classes in physical education which provide for students with physical limitations? (Modified physical education, individual sports, correctives, etc.)

a) Junior high school? Yes, 31; No, 9; No answer, 11.

b) Senior high school? Yes, 36; No, 6; No answer, 9.

45. Do you have open air (sunshine) rooms for students who are tuberculous contacts, asthmatics, cardiacs, etc.?

a) Elementary schools? Yes, 22; No, 20; No answer, 9.

b) Junior high school? Yes, 12; No, 19; No answer, 20.

c) Senior high school? Yes, 7; No, 23; No answer, 21.

46. Is any instructor permitted to teach physical education in the secondary schools who has not majored in physical education? Yes, 18; No, 28; No answer, 5.

47. Do you have paid pianists for high school physical education classes? Yes, 16; No, 29; No answer, 6.

a) Paid by whom? Board of Education, 13; High school, 3; Athletic association, 1; W.P.A., 1.

48. Does the program include girls' sports (play) days?

a) Junior high school? Yes, 29; No, 10; No answer, 12.

b) Senior high school? Yes, 40; No, 3; No answer, 8.

49. Do you have the following sports days:

a) Volleyball? Yes, 30; No, 10; No answer, 11.

b) Basketball? Yes, 31; No, 8; No answer, 12.

c) Swimming? Yes, 17; No, 14; No answer, 20.

d) Tennis? Yes, 27; No, 7; No answer, 17.

e) Individual sports? Yes, 26; No, 9; No answer, 16.

f) Others? Table tennis, 1; Archery, 2; Badminton, 3; Softball, 3; Hiking, 1; Horseshoes, 1; Ice skating, 1; Golf, 1; Soccer, 2; Hockey, 2; Shuffleboard, 1; Gymnastics, 1; Achievement tests, 1.

50. What is the salary range of a physical education instructor:

a) Elementary Grades? $804 to $3,725.

b) Junior high? $804 to $4,000.

c) Senior high? $804 to $4,600.

Effect of Gelatin on the Work Output of Male Athletes and Non-Athletes and Girl Subjects

By Regidius M. Kaczmarek

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Boothby[1]* reported that glycine ingestion may be of benefit to patients with benign types of asthenia. The Council on Foods of the American Medical Association[2] cautioned that gelatin although well tolerated can furnish but a small proportion of the proper dosage of the aminoacetic acid which is 20 to 30 gm. in the treatment of myasthenia gravis or pseudohypertrophic muscular dystrophy. It, therefore, did not recognize the efficacy of gelatin as a source of glycocoll in the treatment of some of the myopathies. Wilder[3] was capable of more sustained effort after adding glycine to his diet. These studies, together with a growing understanding of the chemistry involved in muscle contraction, have led to the investigation of gelatin as a possible source of one or more precursors essential to muscular work.

Many explanations are offered and theories advanced for the increased work output which was observed during gelatin feeding. Experiments by Lusk,[4] and Ringer and Lusk,[5] proved that a number of amino acids, viz., alanine, aspartic acid, glutamic acid, and glycine (all constituents of gelatin) are glucogenetic. Dakin[6] has later demonstrated that in addition to the above-mentioned amino acids, the following: arginine, cystine, proline, and serine are glycogenetic. These last-mentioned amino acids, not unlike the glucogenetic, are also found in gelatin.

Ray *et al.*[7] studied the effect of gelatin on muscular fatigue in a group of medical students, comprising six men and four women. Each subject rode the bicycle ergometer until he became fatigued, and his total energy output per day was recorded in watts. These investigators reported an increase in watt output of 37 per cent to 240 per cent, as compared with the maximum produced during the training level. The women subjects, however, proved to be ill-adapted to these tests. The increased work output during gelatin feeding was attributed by these investigators to the creatinogenic action of the amino acids, especially glycine which makes up 25 per cent of the weight of gelatin.

Glycine is considered to be one of the several precursors from which creatine is formed. Borsook and Dubnoff[8] demonstrated that glycocyamine is converted by methylation into creatine by surviving

* Refer to numbered Bibliography at end of article.

liver slices. They found that glycocyamine itself was formed with great rapidity by rat kidney from and by transamidination of arginine and glycine.[9] Glycine, according to Rose,[10] can from the standpoint of nutritive importance be dispensed within limits. The power of the animal body, however, to synthesize this optically inactive amino acid is limited. Wishart[11] showed that hardihood to the long distance cycling was best maintained in the cyclist on diets rich in protein. This, and the observation of Mirski *et al.*[12] that the potential energy derived from high protein diets behaved differently than that which issued from carbohydrates, suggests that gelatin feeding may be of advantage in arduous work. Hellebrandt and her associates[13] reported that gelatin had no effect upon the ability of women to perform maximal anaerobic work.

In a quantitative study of work an accurate measure of expended energy is essential. Zuntz[14] was the first to use a brake ergometer to determine the mechanical efficiency of the human body. Johannson,[15] in studying the amount of work done by man, employed the raising of weights.

A bicycle ergometer patterned after the Atwater Benedict[16] type was used in the present studies. It was modified by replacing the rear wheel of the bicycle and the friction wheel on the armature shaft of the generator by sprocket wheels and a chain drive. This arrangement was found to establish a constancy to friction. The ergometer was calibrated for work input by the spring deflection method. The work input was dependent on the fixed rate of pedaling. The range observed varied from 64 to 92 revolutions per minute: 64 revolutions equivalent to scale reading 0.095 = 10,196 foot-pounds of work per minute; 92 revolutions equivalent to scale reading 0.160 = 13,200 foot-pounds of work per minute. The girls rode at approximately half the resistance of the men. They pedaled at 66 revolutions per minute equivalent to scale reading .065 = 8,160 foot-pounds of work per minute. Each subject was made to train in daily riding for a period of one or two weeks. The preliminary tests of adaptation to a specific rate of pedaling are not included in these reports. During the training and all subsequent periods each subject pedaled to exhaustion. The stage of exhaustion was reached when the subject was unable to maintain the rate of pedaling necessary to sustain the previously established scale reading peculiar to him or her as an individual.

The environment in which the subjects worked was, from day to day, as nearly alike as possible. Precaution excluded all manner of extrinsic causes likely to induce psychic reactions.

I. ATHLETES AND NON-ATHLETES

The daily energy output of each subject was recorded in foot-pounds of work. The daily average output per week for each group

is plotted graphically. Each point on the charts is an average of sixty tests per week.

The subjects were university students and were divided into two groups: athletes and non-athletes. All subjects ate at the university commons where a uniform dietary was maintained. During specified periods the regular dietary was supplemented by 1.5 ounces of gelatin daily, divided into two portions and administered by dispersion in fruit juice. The athletes took active part in varsity competition. The weight of these subjects ranged from 145 to 200 pounds. They worked to exhaustion on the ergometer daily, not on Sundays, for a total of four weeks, receiving only the regular diet; and daily, except Sundays, for a total of six weeks, each subject received the specified quantity of gelatin daily. The results are plotted in Chart I and show a daily average work output for the "off" gelatin period of 19,027 foot-pounds as compared with 60,108 foot-pounds daily output for the "on" gelatin period—an increase of 216 per cent in the daily average work output during the gelatin feeding.

By contrast with the athletes, the non-athletes, weighing 125 pounds to 190 pounds, were physically untrained and lived moderately sedentary lives. They were available for a much shorter time than the athletes. Therefore, the experimental period "off" gelatin was limited to three weeks and the period "on" gelatin was of like duration. The daily average work output was computed per week and is plotted in Chart I. The results show a daily average work output of 46,340 foot-pounds for the "off" gelatin period as compared with 70,240 foot-pounds daily average output for the "on" gelatin period, or an increase of 52 per cent in the daily average work output during the gelatin feeding.

From a comparison of the values for work output of the experimental subjects, it would appear that the non-athletes have a greater power for work than the athletes, but it will be shown presently by studies on a single subject how the work output decreases as the rate of pedaling and resistance increase. It suffices here to point out that the athletes worked at an average .160 (scale reading) while the non-athletes worked at an average .136 (scale reading), a considerable difference in rate of power output between the two groups. At an indicated scale reading of .160 or pedaling at 92 revolutions per minute the athletes as a group, during the training period, performed but 41 per cent of the work output of non-athletes who worked at a scale reading of .136 or 82 revolutions per minute. These respective rates of pedaling were maintained throughout the experiment. The percentage gain in work output "on" gelatin: athletes 216 per cent; non-athletes 52 per cent. (See Chart I.)

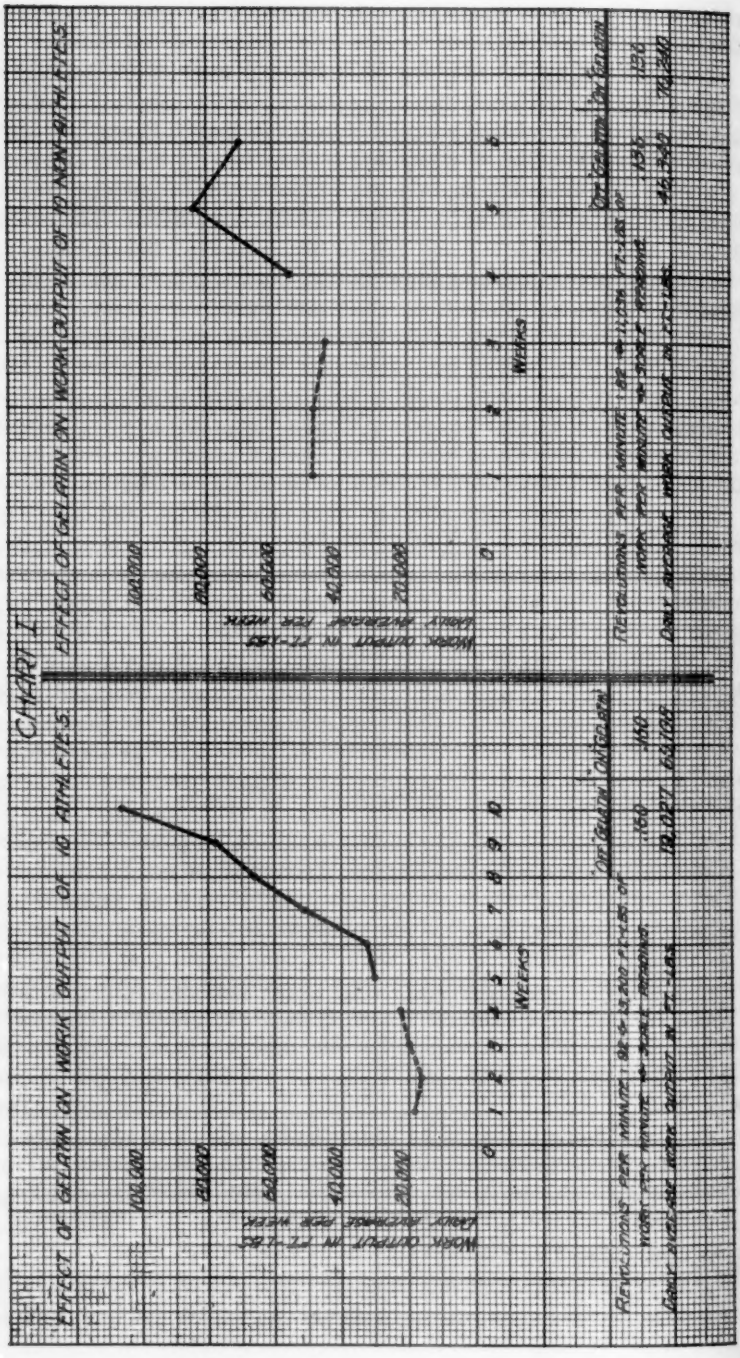
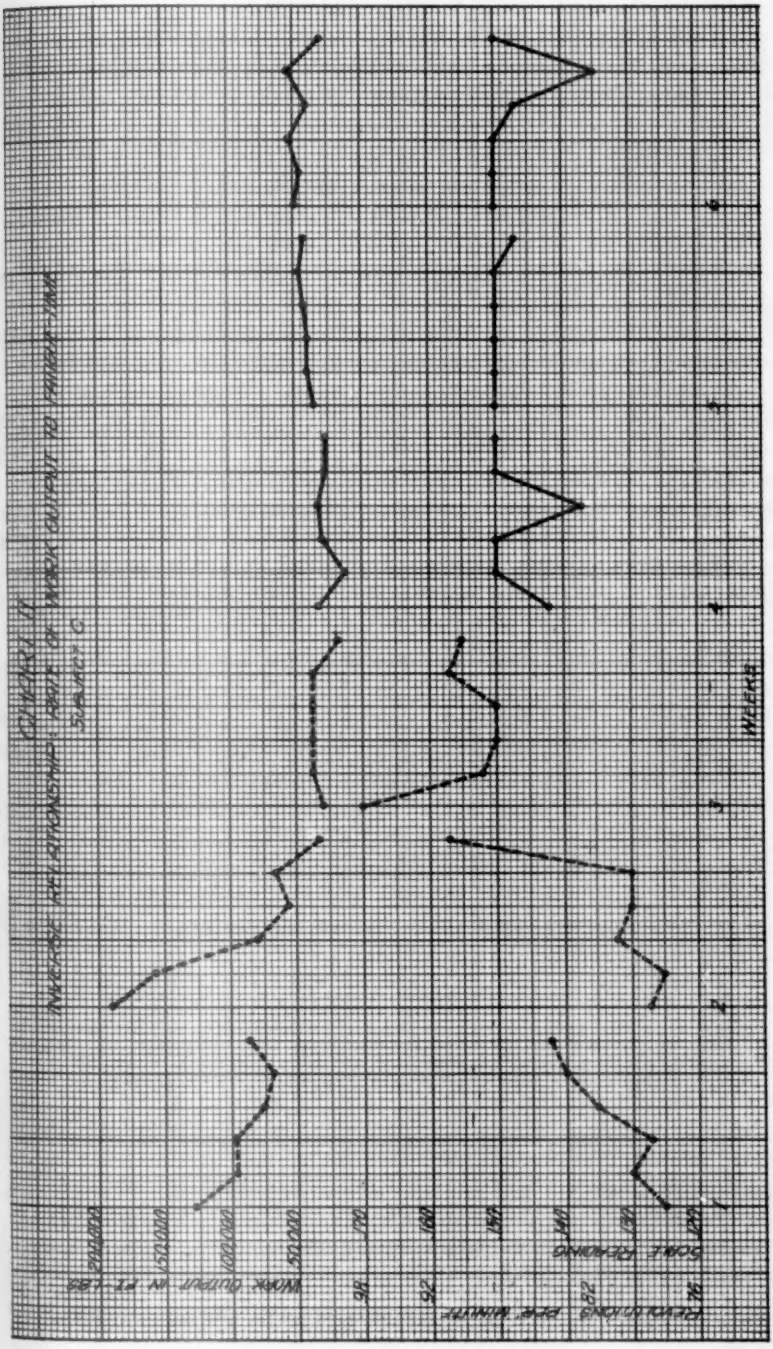


CHART I
EFFECT OF GELATIN ON WORK OUTPUT OF 10 ATHLETES
EFFECT OF GELATIN ON WORK OUTPUT OF 10 NON-ATHLETES
WORK OUTPUT IN FT-LBS
DAILY AVERAGE PER WEEK
100,000
80,000
60,000
40,000
20,000
0
1 2 3 4 5 6 7 8 9 10
WEEKS
Deficiency Criterion
Deficiency Criterion
Personnel are weighed at the beginning of the week and the amount of gelatin to be consumed is measured out in accordance with the weight.
Personnel are weighed at the beginning of the week and the amount of gelatin to be consumed is measured out in accordance with the weight.


CURVES OF WORK DONE BY FINGERS IN SUCCESSIVE PERIODS OF ONE MINUTE
SERIES C
SYSTEM
WORK DONE IN FT. LBS.
SOME GELATINE
GELATIN TAKEN

A minimum gain in work output, as contrasted from week to week, occurred at the end of the training period. Gelatin feeding reversed this order; the maximum gain occurred in the final week of the test. This decremental order of maximum to minimum weekly gain in efficiency by exercise, and the incremental order of minimum to maximum "on" gelatin, was observed in all subjects studied.

The relationship of power to work output is best illustrated by the studies on subject "C." The human being is an engine from the myoneural point of view and, as such, each person has an optimum functional rate for the maximum yield of work. This is the efficiency level which is established during the preliminary testing period and, once fixed, should be maintained constant for each individual throughout the experiment, i.e., work output per unit time remains constant, and the time of riding is the only variable. A specific pedaling rate corresponds to a definite work intensity or horsepower. It was observed that, as the rate of pedaling declined, the total work output rose and, conversely, as the pedaling rate increased the total work output declined. (See Chart II.) The curve of work output is very regular subsequent to the time when the optimum rate of work was established for the individual. This close control of the rate of pedaling is imperative in any studies on the evaluation of the total work output.

Since, as already intimated, the greater gains in work output occurred in the forepart of the training period, it was considered advisable to evaluate the comparative merits of training as contrasted with those which occurred during supplemental gelatin feeding. To this end ten subjects were chosen, five of whom were given gelatin for a period of three weeks without any preliminary training. The work output during this period exceeded that of the subsequent three weeks. (See Group II, Chart III). With subjects of Group I, Chart III, the procedure was different in that gelatin was added to their diet after three weeks of training. In this instance, also, the work output during the gelatin period was the greater. In each of the two groups the influence of gelatin was superior to that of mere training.

II. GIRL SUBJECTS

Ray *et al.*[7] stated that the four women subjects gave no increase in work output on a regular diet supplemented with gelatin. But since De Barenne and Tervaert[17] reported that the creatine content of voluntary muscle is quite constant for the same species, and because many investigators,[18] moreover, have shown that glycine increases the creatine content in muscles of normal experimental animals, and furthermore because Tracy and Clark[19] had reported that in athletic women the creatinine coefficients are similar to those of men, we considered it of sufficient importance to reinvestigate the effects of gelatin on the work output of girls. In addition to the initial pulse taken

before the physical exertion, there were ten pulse counts recorded after each daily test for a period of ten consecutive minutes, the first of which was taken one minute after work.

In many animals, the rabbit being an example, the pale muscles are capable of more rapid contraction than the red muscles. This increased efficiency is associated with an increased phosphocreatine content. Martino and his coworkers [20] found that pale muscle contains 25 to 28 mg. of phosphocreatine per 100 gm. of muscle in contradistinction to red muscle which contains 10.5 to 14.0 mg. per 100 gm. of this tissue.

We chose twelve girls, 15 to 17 years of age, as subjects for this research. They too, not unlike the men subjects, daily rode the ergometer until they became exhausted. For the convenience of these (girl) subjects temporary quarters were set up in the city of South Bend to carry on this research. The average weight of these subjects was 115 pounds. As a rule, the fluctuation in weight was limited to a few ounces.

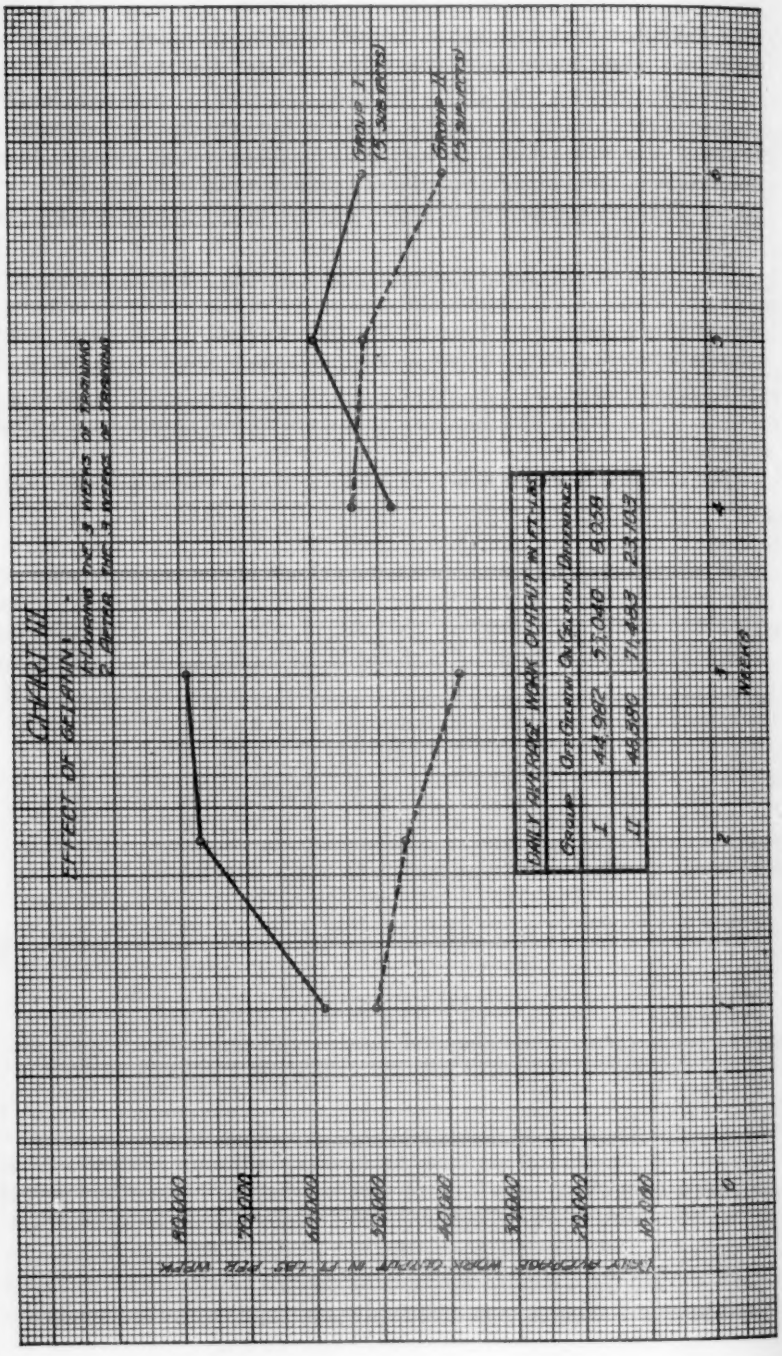
The average scale reading at pedaling by the twelve subjects was 0.065 with a variation no greater than $\pm$ 0.005. Pedaling at this rate was equal to 8,160 foot-pounds of work per minute.

Twelve weeks in all were devoted to the study of work output and pulse rate. Records of the first two weeks are not included in the group report. In this so-called preliminary period each subject ascertained her optimum speed of pedaling. The variation in work output from week to week during the training, gelatin, and post-gelatin periods is shown in Table I.

TABLE I

Period	Training (4 weeks)				Gelatin (4 weeks)				Postgelatin (2 weeks)	
Week	1	2	3	4	5	6	7	8	9	10
Work output in foot-pounds	21800	29800	31400	27500	35900	59100	91000	136100	113400	73000
First week output as basis for comparison	100	137	144	126	165	271	418	627	520	335
Changes from week to week		+37	+7	−18	+39	+106	+147	+209	−107	−185

As is evident, the initial week of the training period is used as a basis for comparison. The gain in work output during the training period was 26 per cent; at the conclusion of the four weeks of gelatin feeding there was an added increase of 501 per cent. The maximum work output during the training and gelatin periods, with reference to the initial week of training, was 1.44 and 6.27 respectively. In the subse-


Group I
Group II
Group
Mean
Standard Deviation
Error
Difference
Critical Ratio
Probability

quent two weeks during which no gelatin was taken (post-gelatin period) there was a decrease in work output from the maximum of the gelatin period by 17 per cent in the first week, and 46.5 per cent in the second. In spite of the decrement in work output during the post-gelatin period, it was greater by contrast with that during training. The cumulative influence of exercise, however, did not compensate for the withdrawal of gelatin from the diet. (See Chart IV; also Group II, Chart III.) The extended benefit in the post-gelatin periods was presumably due to the stored phosphocreatine since Rose, Ellis, and Helming [21] have found that creatine can be stored in the muscles of man.

During training the daily average work output increased from 21,800 to 27,500 foot-pounds. The maximum "on" gelatin was 136,100 foot-pounds.

CONCLUSION

I. Athletes and Non-Athletes

1. Ten athletes increased their daily average work output by 216 per cent while supplementing their daily diet with 1.5 ounces of gelatin.

2. Under similar test conditions ten non-athletes showed an improved work output of 52 per cent during gelatin feeding.

3. The inverse relationship of the rate of work and its summation is demonstrated in this study and shows the necessity of maintaining a constant cycling rate throughout the experiment for purposes of comparing work output.

II. Girls

1. The relative gains in work output at the termination of the training and gelatin periods (Chart IV) were 26 per cent and 501 per cent respectively.

2. The maximum training gain in work output occurred in the third week and was 1/12 of the maximum gain during gelatin feeding.

3. In the first week of the post-gelatin period there was a 17 per cent decrease in work output by comparison with that in the preceding week, the final week of gelatin feeding which was characterized by the maximum output of work.

The second or final week of this post-gelatin period was marked by a further loss in work output of 465 per cent.

4. Gains in work output were irregular during training. During gelatin feeding, however, these trends were progressively positive.

5. The greatest increment in work gain during the training period occurred in the initial week; whereas during the gelatin period the increment gain was most marked in the final week.

6. During the training period of four weeks' duration there was a gradual lowering in the pulse rate one and ten minutes after fatigue. A still further decrease in rate was observed during the gelatin period, despite the greater yield in work output.

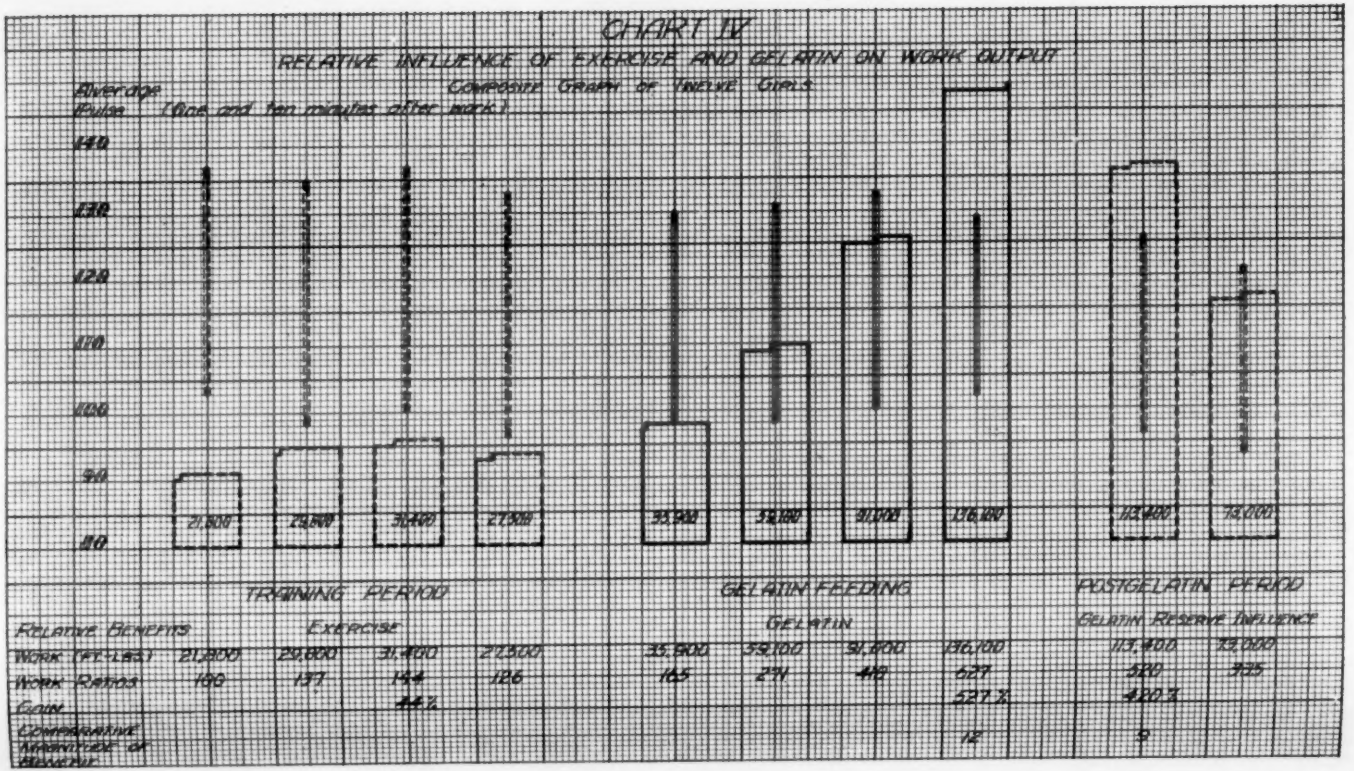


CHART IV
RELATIVE INFLUENCE OF EXERCISE AND GELATIN ON WORK OUTPUT
Composite Graph of Twelve Girls
Average Pulse (One and ten minutes after work)
140
130
120
110
100
90
80
21,800
29,800
31,400
27,500
35,900
33,100
31,200
36,100
33,400
33,000
TRAINING PERIOD
GELATIN FEEDING
POSTGELATIN PERIOD
Relative Benefits
Exercise
Gelatin
Gelatin Reserve Influence
Work (Ft-Lbs.) 21,800 29,800 31,400 27,500 35,900 33,100 31,200 36,100 33,400 33,000
Work Ratios 100 137 144 126 165 274 410 627 520 425
Gain 44% 527%
Comparative Magnitude of Reserve 12 9

7. Further experiments are now in progress on the effects of gelatin and sham feeding on work output, heart and pulse rates.

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A Comparative Analysis of the Physical Education Background, Interests, and Desires of College Students as an Evaluation Procedure

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THE Physical Education Department for Women at the University of Michigan, in accord with present curriculum trends, each year attempts to evaluate its curriculum. This curriculum has been based on a concept that physical education for college women should be such that it considers the interests and needs of each individual student. To evaluate such a curriculum, it appears self-evident that we must first be familiar with the previous experiences and training which a student has had in physical activities; we must know something of the student's interests in these activities; and we must appreciate the desires of a student for further work in this line.

This paper is a report of this phase of the evaluation program. It attempts to answer the following questions concerning the student:

1. What experience has she had in physical activities? This to include both curricular and extra-curricular experiences.
2. What are her interests in physical activities?
3. What further training does she wish to have?

In the absence of any definite or specific technique which could be used as an approach to these problems, the department developed in 1932 a "Physical Education History Blank." The information obtained from these blanks has been changed only slightly from year to year as the scope of the curriculum changed. (See appendix for 1939–40 blank.) Because of this fact it has been possible not only to study the results from year to year but also to make comparative studies over a period of years. The method of obtaining such information has also changed slightly. The blanks are now sent out with registration material, so that certain portions can be filled out by the high school.

The question of the validity of this method has always been a very real question. No specific technique has ever been set up for actually validating the procedure except the reviewing of the results from year to year, and at the present time over a period of seven years. It has been found, as will be noted, that in many respects the

results have maintained a certain close similarity each year. Since the students who fill out these blanks come from many different schools and from all parts of the country, and since this similarity in results still remains, it is believed that a sufficient amount of validity for the results can be claimed. It is also believed that, because of this fact, the changes which occur in the results over a period of years must be significant and present a device for determining trends in interest and practices.

The study will be reported in four parts in accord with the questions given above. The results for the present year will be presented first. Comparisons with the results for the preceding years will be given whenever this is possible and when they seem significant.

PART I

WHAT PHYSICAL EDUCATION EXPERIENCES HAVE THE STUDENTS HAD IN HIGH SCHOOL?

Since many agencies have developed programs which offer specific training in, or opportunities for, physical activities, we have first attempted to analyze the physical education training which the student received in the junior and senior high school. A report of work carried on under the supervision of other agencies is given in Part II.

No attempt has been made to determine the actual number of hours which a student devotes to the required physical education program in high school. It seemed preferable to consider the various types of activities which the student experienced in her required courses or in work carried on under the supervision of the school, as well as the amount of time (in terms of number of periods, not clock hours) spent in these particular activities.

This information for 484 freshman women entering the University in 1939 has been tabulated and is given in percentage form in Table I, as well as similar information for 1937 and 1938.

It will be noted in this table that for the year 1939, baseball, basketball, and volleyball — all team games — are the activities most frequently offered in both the junior and senior high schools. If a rhythmic activity is included on either of these levels it is apt to be folk dancing. Gymnastics, which probably includes stunts and tumbling, appears to be the only individual activity which is offered by any number of schools at the junior high school level. There does seem to be some difference between the junior and senior high school in this respect. Gymnastics continue to be given in the senior high school but, in addition, at least a fifth of the students have an opportunity to participate in badminton, tennis, swimming, tap dancing, and social dancing.

The content of the physical education programs at the junior and senior high school levels for those students who come to the University

has changed very little in the last three years, as is shown in this table. A similar analysis of data collected previous to 1937 has not been included, since the division between junior and senior high school levels was not made in the data until that year.

Although slight yearly fluctuations and decreases in the types of activities offered in the high school programs will be noted, certain similarities are outstanding. These similarities are more surprising when one considers the fact that these students are from high schools all over the country. Perhaps the slight fluctuations and decreases from year to year are due to this fact rather than to actual changes made in schedules in the high school physical education curricula.

TABLE I

PERCENTAGE ANALYSIS OF ACTIVITIES EXPERIENCED IN THE JUNIOR AND SENIOR HIGH SCHOOLS BY WOMEN ENTERING THE UNIVERSITY IN 1937–38, 1938–39, 1939–40

Activities	1937–38		1938–39		1939–40	
	Jr. H. S.	Sr. H. S.	Jr. H. S.	Sr. H. S.	Jr. H. S.	Sr. H. S.
Baseball	72	38	72	60.1	66	59.2
Basketball	66	50	70.9	75.9	69.9	71
Field ball	17	6	16	8.8	12.1	8.1
Field hockey	25	22	22.8	32	19.7	28.5
Soccer	27	11	29.7	22.8	28.4	21.8
Volleyball	61	38	63.4	61.2	65.5	61.4
Archery	3	6.6	2.5	9.4	4	15.3
Badminton	2.4	9	4.3	13.4	4.3	22.2
Bowling	3	4.1	4.1	6.5	2.4	8.1
Camping act.	—	—	—	—	5.7	1.6
Canoeing	1	.4	1.2	2.3	2.8	1
Correctives	7	8	8.5	7.3	4.8	6.6
Fencing	.1	.5	.5	2.0	.4	1.8
Golf	1	3	.2	3	2.4	5.8
Gymnastics	48	26	43.8	33.4	32.6	35.9
Hiking	5	6	5.5	8.3	10.3	8.1
Lifesaving	—	—	—	—	3.2	4.8
Riding	7.6	5	1.4	4.9	5.4	5.2
Skating	4.2	2.4	4.9	7.3	10.1	3.4
Skiing					2.6	1.6
Swimming	25	18	20.5	26.6	17.8	24
Tennis	12	19	12	24.7	15.7	26.1
Folk dance	33	21	35.8	37.8	26.1	41.3
Ballet dance	—	—	—	—	3.6	2.8
Modern dance	4	12	3	18.3	3.4	11.6
Tap dance	11	19	25.3	29.9	18.4	22.4
Social dance	—	—	—	—	19.1	23

In addition to determining the kind of activities experienced and the approximate time spent in each activity, an attempt has been made this year to learn something of the skill of the student in these various activities. The high school physical education instructor was asked to give this skill rating. (See directions given on the Physical Education History Blank.)

An analysis of these ratings is given in Table II. The per cents for each activity given in this table are based on the number of ratings given. The parenthetical numbers represent the total number of students rated in each activity. When the total number of students who were rated in any specific activity was less than thirty-five, no percentages are given.

TABLE II

PERCENTAGE ANALYSIS OF THE SKILL RATINGS OF THE STUDENT AS GIVEN BY THE HIGH SCHOOL INSTRUCTOR, 1939–40

Activities		Excellent	Good	Average	Fair	Poor
Baseball	(257)	7.0	36.1	33.0	20.6	3.1
Basketball	(305)	11.1	42.2	30.1	15.4	0.9
Field ball	(31)					
Field hockey	(128)	13.2	43.7	20.3	20.3	2.3
Soccer	(89)	12.3	49.4	23.5	13.4	1.1
Volleyball	(267)	10.4	50.9	24.3	13.8	0.3
Archery	(66)	3.0	42.4	31.8	19.6	3.0
Badminton	(109)	13.7	44.0	22.9	19.2	0.0
Bowling	(37)	5.4	54.0	21.6	13.5	5.4
Camping act.	(8)					
Canoeing	(9)					
Correctives	(24)					
Fencing	(7)					
Golf	(18)					
Gymnastics	(166)	16.8	45.1	22.8	14.4	0.6
Hiking	(35)	31.4	42.8	17.1	8.5	0.0
Lifesaving	(25)					
Riding	(22)					
Skating	(19)					
Skiing	(10)					
Swimming	(111)	26.1	41.4	15.3	12.6	4.5
Tennis	(114)	13.1	38.5	22.8	22.8	2.6
Folk dance	(151)	13.9	51.6	23.8	9.9	0.6
Ballet dance	(12)					
Modern dance	(44)	13.6	38.6	9.0	36.3	2.2
Tap dance	(83)	15.6	43.3	16.8	22.8	1.2
Social dance	(101)	22.7	45.4	24.8	6.9	

A review of this Table seems to indicate that in general the majority of the students coming to Michigan as freshmen have more than average skill in the activities which they have had during their high school years.

Summary, Part I.—It appears that the majority of women students coming to the University of Michigan as freshmen have (1) had experience in team games in high school, (2) had very little experience in individual activities in high school, and (3) had better than average skill in the activities offered in the high school.

PART II

WHAT EXTRACURRICULAR EXPERIENCES HAVE THE STUDENTS HAD IN PHYSICAL ACTIVITIES?

A knowledge of the activities in which a student participates outside of school supervision gives a more complete knowledge of her background and experiences in physical activities. Such experiences may or may not be supervised.

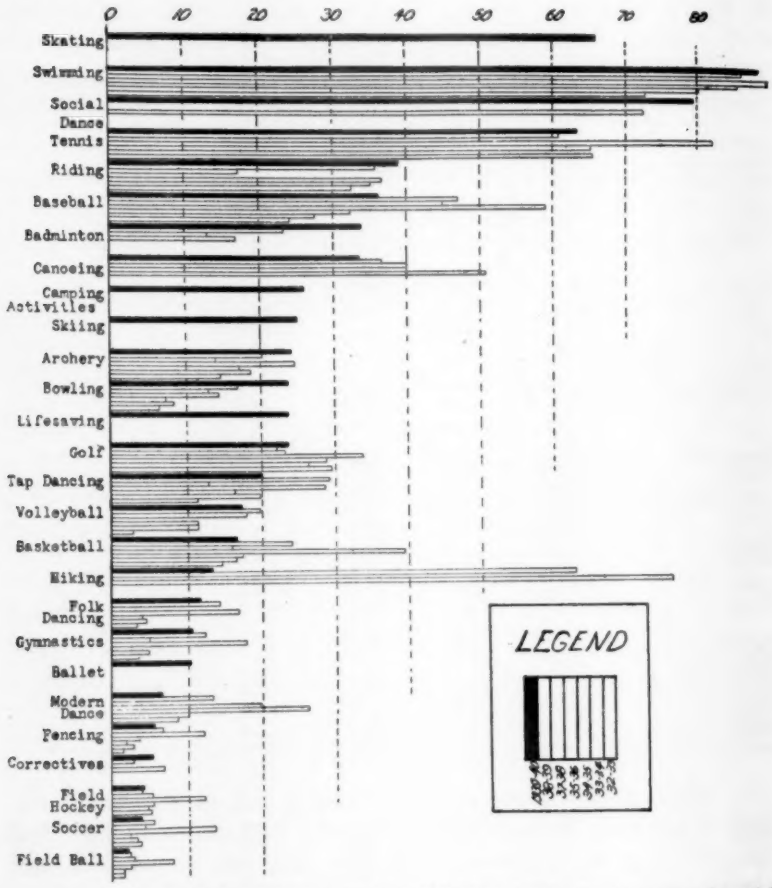

FIG. I. An analysis of the per cent participation by freshman women in activities outside of high school supervision.

The results for the 1939 study as well as for preceding years are given in percentage form in Figure I. It is of interest to note that swimming, hiking, skating, tennis, and social dancing are the activities which are most popular with the 1939–40 students. These activities maintain these top positions even though the students had had experience in the activity for one season, for two seasons, or for three

seasons. A study might very well be made of the inherent qualities of these particular activities to determine, if possible, the reasons why they have this appeal to students of this age level.

Further study of this graph shows how the picture changes from year to year. Tabulations have been made since 1932 (excluding the year 1936). It will be noted that the amount of participation in some activities has changed very little from year to year. Other activities show a rather steady increase and some a steady decline.

It appears that most team games are not popular with girls of this age as "out-of-school" pastimes. There are several reasons why this might be true.

First, the schools themselves might be fulfilling the demand. Table I indicated quite clearly that the bulk of most high school physical education programs is made up of team games. One wonders what the effect would be if the emphasis were placed on individual games in high school.

Second, this lack of participation might be attributed to lack of community facilities. Equipment and space are needed for most team games.

Third, this lack of participation might indicate something fundamental in the make-up of the woman student at this age level, since this same lack of participation is not observable with boys. It can be commonly observed that boys play team games such as baseball, football, and basketball out of school as well as in their school program. It may be that this age group has been incorrectly designated as the "team age" for girls. Since they mature earlier than boys, they might have passed beyond this level when they are in high school.

A further analysis of these "out-of-school" activities has been made to determine which agencies are contributing to the leisure-time activities of these students; something of the program which these agencies offer; and the number of students who have participated in these programs. Table III gives a list of the various organizations which were reported by the students. This table also includes the per cent of students participating in each of the activities sponsored by the various organizations. These per cents were computed from the total number of students reporting "out-of-school" participation in the various activities. The parenthetical numbers represent these totals.

It will be readily noted that more girls participate in the camping program than in the programs of other organizations. It also appears that the scope of the camping program is broader than for the other organizations. However, it is enlightening to note the number of different organizations which in some way are fostering physical activity programs. It is also of interest to note that relatively few students receive instruction from special teachers or special schools in any of the activities except dancing. It is curious that this particular custom has grown for dance and not for the other activities.

Summary, Part II.—A study of the "out-of-school" activities reveals that: (1) swimming, hiking, skating, tennis, and social dancing are most popular, regardless of the number of seasons which the students have spent in playing the activity; (2) many students participate in the physical activity programs sponsored by other organizations, the camping programs being particularly outstanding in this regard.

TABLE III

AN ANALYSIS OF THE PERCENTAGE OF STUDENTS PARTICIPATING IN ACTIVITIES SPONSORED BY EXTRACURRICULAR ORGANIZATIONS, 1939–40

Activity	No.	Camp	Y.W.C.A. Girl Reserves	Jr. Y.W.C.A.	Camp Fire Girls	Girl Scouts	G.A.A.	Club or Team	(Special) School	Private Teacher	Church	City and Recreation Center	Miscellaneous
Baseball	(216)	21.7	2.7		1.3	2.7	1.8	.4			.8	1.8	.4
Basketball	(102)	14.7	7.8	1.9	.9	3.9	9.8	4.9			5.8	3.9	1.9
Field ball	(22)	18.1					4.5						9.0
Field hockey	(27)	25.9					11.1	3.7					7.4
Soccer	(25)	40.0	4.0			4.0		2.0				4.0	2.0
Volleyball	(108)	34.2	3.7	2.7		6.4	15.7	2.7			2.7	1.8	.0
Archery	(139)	48.9	6.4		2.1	4.3	1.4	1.4		1.4			1.4
Badminton	(190)	11.0	3.1	1.0		.5	2.1	1.5	.5	.5	.5	2.6	.5
Bowling	(127)	3.1	.7			1.4	2.3	1.4	.7	.7			
Camping act.	(194)	44.8	6.7	.5	2.0	17.5		.5			1.5		1.5
Canoeing	(164)	42.7	3.0		1.2	1.8							
Correctives	(27)	7.4				3.7				3.7			11.1
Fencing	(35)	40.0	11.4				2.6	2.6	2.6	5.7			2.6
Golf	(143)	4.1						6.9		5.5			
Gymnastics	(48)	12.5	6.2	2.0				2.0		4.1	2.0	2.0	2.0
Hiking	(307)	21.4	2.6		.3	11.7	.6	.6			.6		.6
Lifesaving	(112)	44.6	9.8	.8	2.6	6.2							11.6
Riding	(224)	17.8	1.3			.4		3.1	.8	6.2			.8
Skating	(351)	1.1	.8			.8	.6	.3					
Skiing	(133)					.7	.7						
Swimming	(438)	15.7	5.0	.4	.4	2.5	.2	1.1		.4	.4		.4
Tennis	(354)	10.1	.8				.5	1.6		.2		.8	
Folk dance	(67)	34.3	5.9		1.5	22.3		2.9	2.9	2.9	4.4		2.9
Ballet dancing	(53)	3.7						1.8	20.7	23.9			
Modern dance	(38)	13.1	5.2						13.1	18.4			
Tap dancing	(112)	4.4	5.3					.8	16.9	24.1		.8	1.7
Social dancing	(389)	.2	1.2					1.0	5.1	5.1			.7

PART III

WHAT ARE THE INTERESTS OF STUDENTS IN PHYSICAL ACTIVITIES AT THE TIME OF ENTRANCE TO COLLEGE?

It has been recognized frequently that for one reason or another individuals do not always participate in the activities which they like best. Lack of time and facilities, expenses connected with games, etc.,

may account for this. Therefore it was of interest to have the student check the activities which she liked best. No attempt was made to have the student check the order of preference but merely to check the best-liked activities.

The results for this year as well as the preceding years are given in Figure II. Again it will be noted that the per cent of students interested in certain activities remains fairly constant year after year. Swimming always seems to head the list as the favorite sport for the largest number of students. Tennis and social dancing are the only other activities checked by as many as 50 per cent of the students.

Interest in certain sports seems to be definitely on the increase. Baseball, archery, badminton, bowling, and riding are examples. Again, we may well ask why? Since few high schools include these sports in their curriculum, one must look to other agencies or to other factors if one is to understand the source of this interest. Doubtless there are many factors which are influential, such as (1) the possible relationship of skill and interest, and (2) the possible relationship of amount of participation and interest. As a result of the first assumption, much of the emphasis in the teaching of activities has been placed on the development of skill. By having the student rate herself in these activities it has been possible to throw some light on this commonly accepted principle.

Each student was asked to rate herself in the various activities in which she had played. She was told to compare herself with the girls whom she considered average players in her group. It is recognized that this type of rating is very subjective and that some girls will overrate themselves while others will underrate themselves. However, this may be a more satisfactory means of comparing skill and interest than it would be to have a student rated objectively by a given test. For example, it is conceivable that a student might be rated low on an objective test, yet might have been above the average of the students with whom she played. If this student received satisfaction from this type of activity because of her skill, it would be a satisfaction based on a relative degree of skill, not on her skill when compared with the top ranking players or even with average ranking players.

Space does not permit the inclusion of charts developed to show these self-ratings for the 1939 group. Suffice it to say that in these individual diagrams certain of them show characteristics similar to a bell-shaped curve, while others are skewed to the left or right.

If the assumption is correct that skill and interest go hand in hand, the data should show that a student who feels that her skill in an activity is good or excellent should also select that activity as one of her best liked.

Table IV shows the per cent of students rating themselves in the various activities who also list the activity as one of the best liked.

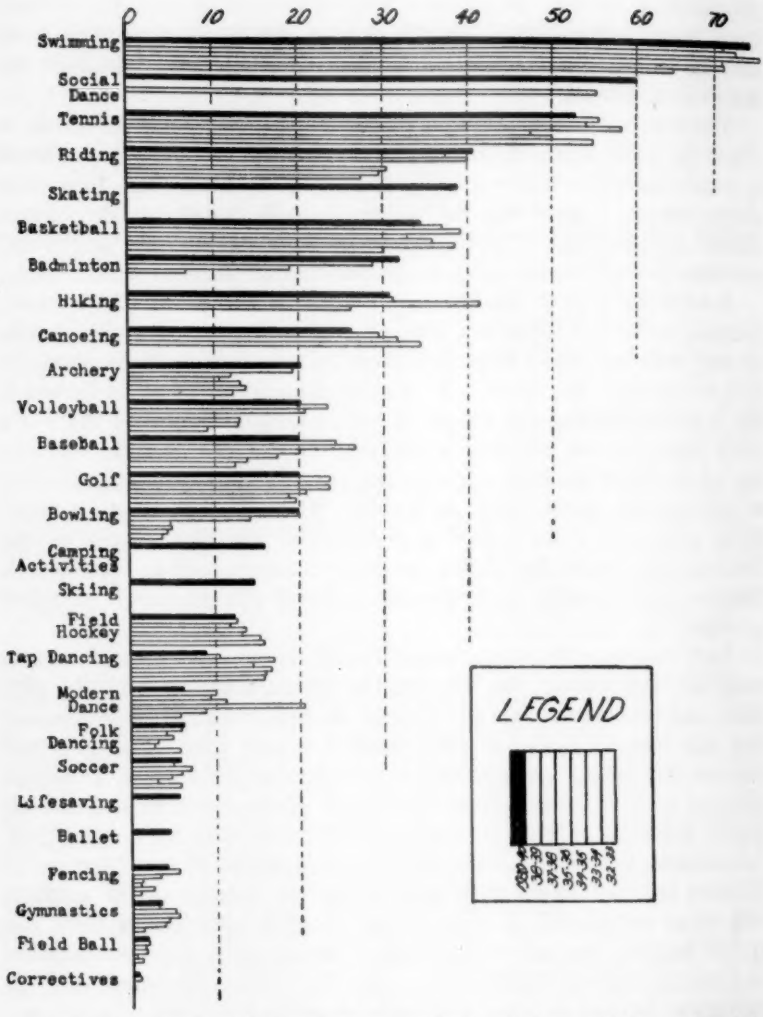

FIG. II. A comparative percentage analysis of the activities preferred by entering freshman women.

In this table only activities were selected which had a representative number of ratings. Even then we should only consider the results as indicating trends, for in many activities the number of students rating themselves in the various skill classifications is very small. This is true especially in the excellent and poor groups.

In terms of these results some rather interesting trends appear. Considering the team games, the chances are very good that those who have rated themselves as having excellent skill, will rank the ac-

tivity as one of their best liked. At the same time those who consider themselves as being definitely inferior or who have a skill rating of poor, will more than likely not rate that activity as one of their best liked. Over half of the group who rate themselves as good in an activity will check that as one of their best liked activities and approximately 50 per cent of those who consider themselves as average players will

TABLE IV

PER CENT OF STUDENTS RATING THEMSELVES IN THE VARIOUS SKILL CLASSIFICATIONS WHO LIST THE ACTIVITY AS ONE OF THEIR BEST LIKED

Activities	Excellent	Good	Average	Fair	Poor
Baseball	100.0	54.0	43.3	21.2	3.4
Basketball	100.0	94.1	75.7	50.0	16.6
Hockey	100.0	78.5	65.6	35.2	0.0
Volleyball	88.8	57.8	46.5	25.0	0.0
Archery	no ratings	78.9	73.1	54.8	34.8
Badminton	87.5	86.8	65.5	60.5	38.0
Golf	50.0	91.6	85.7	63.6	41.1
Riding	89.4	88.1	85.0	80.7	66.6
Swimming	94.2	90.6	83.8	66.6	31.0
Tennis	77.7	94.2	88.8	63.1	43.7
Folk dance	71.4	40.0	36.3	8.3	0.0
Tap dance	71.4	53.8	39.3	20.0	14.2

like that activity the best. Even with those who consider themselves as having only a fair amount of skill there will be about 25 per cent who will check the activity as a favorite.

It appears from these data that for team sports, at least, we find a certain relationship between interest and skill. At the same time we should remember that unless a girl is very poorly skilled there will be some who like the game regardless of skill. It would be of value to see what would happen to the interest of a poorly skilled student if the level of skill could be raised. It would also be of value to know something of the strength and permanence of these interests for both the skilled and unskilled group. Will those students who are highly skilled continue to maintain this interest over a longer period than those students who are interested but poorly skilled?

In considering the individual sports in Table IV, the picture changes somewhat. A large majority of those who report excellence in these games will also check them as one of their best liked. Contrary to the team sports picture, however, one finds that over 30 per cent of those who rate themselves as poor in individual sports will check those as favorites. Apparently, the skill factor in these sports is less significant—students can enjoy the game even though they lack skill. From the standpoint of evaluation this should be of significance. It

would be of value to know something of the strength and permanence of this interest in terms of skill.

The number of rhythmic activities analyzed in Table IV is few. If the analysis of these activities is significant, the picture for these is different from either team or individual sports. The percentage of those in each of the skill classifications who list the activity as a favorite are noticeably decreased.

It has also been of interest to determine from our data the relationship of preference for an activity and the number of seasons which a student has participated in that activity. To find this, the data was checked to obtain the per cent of students who, having participated outside of school for one, two or three seasons, also checked these activities as favorites. The results are given in Table V. Per cents were not included in the table for those activities if there were less than thirty-five students who had played the activity for one, two, or three seasons. In general, the one outstanding fact apparent from these results is that many students who participate in activities outside of school do not consider these their best-liked activities. The question

TABLE V

A Percentage Analysis Representing the Number of Students Who Have Played an Activity Outside of School for One, Two, or Three Seasons and Who Select the Activity as a Favorite Activity

Activities	Number of Seasons		
	One	Two	Three
Baseball	31.3	44.1	62.5
Basketball	58.3	80.0	—
Field ball	—	50.0	33.3
Field hockey	—	—	—
Soccer	—	—	40.0
Volleyball	15.0	27.7	92.2
Archery	47.8	46.6	51.5
Badminton	52.2	78.1	47.7
Bowling	48.0	65.2	19.5
Camping activities	27.8	38.7	—
Canoeing	51.0	50.0	—
Correctives	—	—	—
Fencing	—	50.0	—
Golf	53.1	59.6	75.0
Gymnastics	13.3	27.2	20.0
Hiking	40.0	29.2	46.5
Lifesaving	18.3	24.2	18.1
Riding	81.1	53.0	80.6
Skating	46.7	14.0	64.1
Skiing	50.9	15.7	76.6
Swimming	70.4	23.3	86.0
Tennis	57.7	71.4	83.4
Folk dance	23.8	12.5	62.5
Ballet dance	—	37.5	56.2
Modern dance	—	28.5	57.1
Tap dance	12.0	34.7	44.4
Social dance	56.7	65.9	76.9

arises as to what factors influence this participation. For certain of the activities the per cent of students who select an activity as their best liked and who have played the activity for three seasons is greater than the per cent of students who have played that same activity for only one season. Probably the cases are too few to make valid judgments.

A similar analysis was also made of participation and interest for activities carried on in the junior and senior high schools. The same facts were observable for these as are noted in Table V.

Summary, Part III. — It appears from this study of preference for activities:

1. At the present time, the top ranking activities in interest are swimming, social dancing, tennis, riding, and skating.
2. The interest in baseball, archery, badminton, bowling, and riding has shown a steady increase since 1932 (excluding 1936).
3. Students' self-ratings of skill are of value in understanding the basis of sport interests.
4. A study of the amount of participation is also of value in gaining an understanding of the basis of sport interests.

PART IV

WHAT FURTHER INSTRUCTION IN PHYSICAL ACTIVITIES DOES THE ENTERING COLLEGE STUDENT WISH TO HAVE?

In considering the needs of the student on the college level, it is of value to know what the student herself feels that she needs and wishes.

Accordingly, the students were asked to check those activities in which they desired further instruction. (See Figure III.) In comparing these yearly results, several trends will be noted. It is of interest to note the activities in which there appears to be an increasing demand for instruction and those in which the demand is decreasing. These facts are more significant when Figures II and III are compared. It will be noted that a desire for further instruction in a given activity does not go hand in hand with those activities which a student likes best. One wonders if the desire for further instruction is based on the wish to experience an activity—a curiosity about that activity—rather than on a desire for acquiring special skill in an activity.

Summary, Part IV. — The data relating to a desire on the part of the student for instruction in activities at the time of college entrance indicate:

1. Golf, tennis, archery, fencing, riding, and badminton are the activities in which 30 per cent or more of the students desire further instruction.
2. Needs (as expressed by the students) for further instruction in certain activities have shown a steady increase since 1932.

3. Needs (as expressed by the students) for further instruction in certain other activities have shown a rather steady decrease since 1932.

4. Needs for further instruction in activities and the best liked activities do not always go hand in hand.

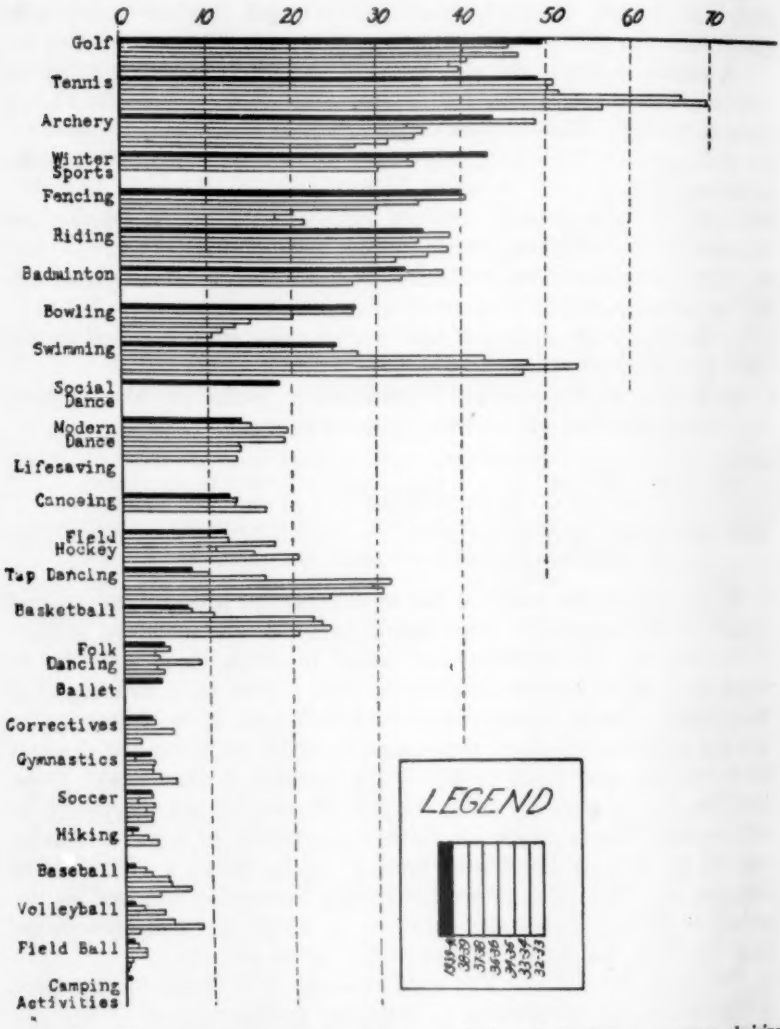

FIG. III. A comparative percentage analysis of freshman women desiring further instruction in activities.

CONCLUSIONS

This four-part study of 484 freshman women entering the Universsity of Michigan in 1939 and a review of similar studies carried on since 1932 (excluding the year 1936) give evidence that:

1. The background of students in physical activities as well as their interests in, and desires for activities can rather quickly be obtained by an analysis of the physical education history blank.

2. The trends in the physical education programs of high schools and other organizations can be followed by yearly surveys of this type.

3. Material of this type furnishes information useful in an evaluation procedure.

APPENDIX

UNIVERSITY OF MICHIGAN
DEPARTMENT OF PHYSICAL EDUCATION FOR WOMEN

Return this blank by September 15 to the following address—Department of Physical Education, Barbour Gymnasium, University of Michigan, Ann Arbor, Michigan.

Name..... High School..... Town ..... State.....

Ring the school in which you are planning to register: Architecture Education L.S. & A. Music

In the outline below, fill in Columns I, II, III, IV, V, and VI. *Do not fill in Column VII.* After you have completed this outline, ask your physical education teacher, principal, or superintendent to fill in Column VII.

In Column I, check all the activities which you have played *outside* of school supervision *within the last five years.* Use one check for each season spent in an activity (one season equals fifteen times). If you have participated in an activity less than 15 times, place in column the approximate number of times (once 1), (twice 2, etc.).

In Column II, if you have played any of these activities in an organized club (i.e., Y.W.C.A., Girl Scouts, City Badminton, etc.), in a camp or under a private teacher, write in name of organization or instructor.

In Column III, check the activities which you like to play the best.

In Column IV, indicate how well you play each activity: "Excellent," "good," "average," "fair," or "poor." Compare yourself with the girls whom you considered average players in your group.

In Column V, check activities which you would like to learn while in college.

In Column VI, check the activities in which you participated while in Junior High School, or 7th, 8th, and 9th grades. Use one check for each season (√ one season, √√ two seasons, etc.).

(*Note: On the original blank, the checklist on page 134 appears here*)

*Column VII *to be filled in by the Physical Education Teacher, Principal or Superintendent*:

Check all the activities which this student has played under school supervision. Use one check for each season spent in the activity (√ one season, √√ two seasons, etc.). A season is approximately fifteen hours of activity under supervision, whether in a class or in the intramural program.

If you are acquainted with the skill of the student in these activities, please indicate with the rating of "excellent," "good," "average," "fair," or "poor." The back of this sheet has been reserved for any comments you might care to make regarding this student which will be of help to us in planning the student's program.

Through physical education at the University of Michigan, an effort is made to help the student gain experience and skill in a variety of activities. In planning the student's program it is essential that the physical education background

Activities	Out-of-School Experience	Name of Organization	Activities Liked	Degree of Skill	Wish to Learn	Activities in J.H. (7, 8, 9 grades)	To be filled in by Instructor in Sr. H. S. (9, 10, 11, 12 grades)	
							VII	
Team Sports	I	II	III	IV	V	VI	Check	Skill Rating
Baseball								
Basketball								
Field Ball								
Field Hockey								
Soccer								
Volley Ball								
Other Team Sports (list)								
Individual or Dual Activities								
Archery								
Badminton								
Bowling								
Camping Activities								
Canoeing								
Correctives								
Fencing								
Golf								
Gymnastics								
Hiking								
Life Saving								
Riding								
Skating								
Skiing								
Swimming								
Tennis								
Rhythmic Activities								
Folk Dancing								
Ballet Dancing								
The Modern Dance								
Tap Dancing								
Social Dancing								

be taken into consideration. For this purpose we are asking your cooperation in accurately checking this outline.

(Note: These ratings will not in any way affect the student's entrance to the University.)

Signature .....

Position .....

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Compiled by G. B. Affleck
Springfield College, Springfield, Massachusetts

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PHYSICAL EDUCATION IN THE SECONDARY SCHOOL. Laurentine B. Collins and Rosalind Cassidy. (New York: Progressive Education Association, 1940) 120 pages, $1.00.

With the current development in curriculum modifications to suit the present-day needs of secondary education, this book provides the workers with a well-organized background.

The manual is the result of a Workshop Study, and the authors have collaborated with specialists to present basic material, that is, authoritative and fundamental to aggressive treatment of the curriculum. Toward this end considerable space has been allotted to a select bibliography entitled "What to Read." These selections, appearing at the end of each section, are the contribution of many leaders in the physical education profession. The appendix lists the members of the Workshop.

The book in no way attempts to deal exhaustively with the problem, but rather attempts to present the underlying philosophy, the basic considerations, and the general direction of curriculum study. A special chapter devoted to the problems of physical education deserves careful and critical study.

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THE SUBJECTION OF WOMAN AND TRADITIONS OF MEN. Maude Glasgow, M.D. (New York: McAuliffe-Booth Co. Press, 1940) 340 pages, $3.00.

This book, privately printed and therefore not as widely publicized as some works, should not be missed by students interested in physical education's history highlights.

After years of research, the author weeded out and selected such fascinating facts about women who have struggled through the ages for the privileges and rights we now enjoy, that the book will be of lasting value.

Reading here of the restrictions which were placed on educational advantages offered, curtailed chances for development of health, lack of opportunities to use acquired knowledge, and social injustice imposed, one is appalled and yet filled with admiration for the few—here named and honored—who refused to be "subjected."

Dr. Glasgow points out that "the remarkable physical advance of women in the past few years is due to physical training" and expresses the belief that women physicians should be in charge of women's athletic work. She advocates "some retarding on the male athletic field" in order to reduce the number of deaths and injuries occurring there. (Her figures give, for 1935, 30 young men who lost their lives from football and 75,900 others injured.)

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TEACHING HEALTH AND SAFETY IN ELEMENTARY GRADES. Willard Walter Patty, Ph.D. (New York: Prentice-Hall, Inc., 1940) 371 pages, $2.50.

With the rapidly increasing interest in health and safety education on the part of both educators and the general public, there is need for a source of readily available information based not only on theory but also on successful practice and ideas that have been experimentally demonstrated.

This text by Dr. Patty, while designed primarily for use in elementary schools, is of much wider application and will prove invaluable for all teachers and educators.

To insure systematic covering in teaching health education, the author suggests a cycle plan whereby ten specified topics would be taught three times each during the elementary school years, adapting each new presentation to the capacity of the pupils and building each lesson around a "featured method."

Emphasis is placed on the health status of the teachers as examples and attention is called to the usual health hazards in teaching. The author claims that "if the schools perform their full duty, every child must learn such knowledge, acquire such attitudes and ideals, and develop such health habits as are necessary for him to live a successful and happy life" (p. 42).

The claim is made that safety and accident prevention are essential parts of health education. The outcomes of this program are listed as health knowledge, health habits and skills, and health attitudes. These are checked in a key code indicating their relative values for the various grades.

Concerning the psychology of teaching in this field, certain laws of learning are particularly emphasized, namely, laws of readiness, of conditioned reaction, of use and disuse, and of effect. The author admits that the methodology of teaching health and safety has reached only the experimental stage.

The Health Service Department may be used as an educational agency showing the "how," "when," and "why," and participation in this service is well calculated to develop an appreciation on the part of pupils.

Physical education may and should have a close tie-up with health education. In reality the physical practice activities should be a laboratory of physical health learning. The author bemoans the habit of inactivity into which increasing numbers are falling and reemphasizes the need for big muscle activity through which the vital organs are stimulated to organic efficiency. Hundreds of young people today are "physical play wallflowers" because the schools have failed to develop in them the necessary skills. There is advanced the further claim that physical education is definitely related to mental and moral health.

Demonstration and oral illustration is one of the best chapters in the book, and here, as in other chapters on methodology, there are given sample lesson plans. The teaching methods used include also visual aids, projects and problems, dramatization, life situations, integration, and correlation. Safety education is covered in chapters 16 to 18, dealing respectively with home and school, streets and highways, and recreation. The bibliography in this section on safety is particularly rich.

There is a fairly complete alphabetical index of five pages. The type is clear on a mat surface paper. Chapters usually conclude with a consideration of directed study and discussion, also suggestions and samples where suitable, followed by a bibliography of selected content and method material.

The book is highly commended and deserves wide distribution as it is a decided contribution to the literature in this field.

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Food Control, Its Public Health Aspects. James Houston Shrader. (New York: John Wiley & Sons, 1939) 513 pages, $4.00.

For health education teachers working in nutrition, this volume will prove a valuable guide. Dedicated to Professor Henry C. Sherman, the book grew out of a course in practical food control which the author gave for five years at Johns Hopkins University.

What is nutrition? What is malnutrition? How prevalent is food poisoning and what are its most frequent causes? These subjects are followed by a thorough discussion of the most valuable single source of natural food—milk. What effect does pasteurization have upon milk's nutritional value? How does the food value of milk sold "loose" vary from that sold in containers—and why? What effect does freezing have?

Powdered milk—and powdered buttermilk, which "is finding a widening use"; condensed milk, which is not sterile, and evaporated milk, which is—all are fully described and compared. The nutritive value of the latter is attributed to the high "retention of calcium and phosphorus" content. Evaporated milk is, according to the author, proving beneficial in adult feeding as well as for use in nourishment of infants and children.

An experiment at the Post Graduate Hospital in New York is said to have shown that *condensed* milk—preserved by use of sugar—may safely be used for infant feedings though generally it is believed not to be as well balanced for a baby's diet as the unsweetened, evaporated milk, or milk in powdered form.

The two processes of powdering are described. "Powdered milk has a high nutritive value for infant feeding," a study made by Price, Park, and Collins clearly showed. "It has been known for a long time that babies fed with boiled milk thrived better than those fed with regular milk." Years of study and research have finally revealed why this is true and the author brings the reader this most recent data.

When purchasing butter one should know how to select it and should understand the differences between "whipped" and "renovated" butter, also the difference between butter and its substitutes from the health viewpoint. "During the World War," Dr. Shrader relates, "serious nutritional disturbances were suffered in Denmark caused by the substitution of oleomargarine for butter."

In the chapter on cheese, the making of various types is described and the food value with percentage composition is given. "Cheese contains more calorific value than an equal weight of most other food products. The action of the micro-organisms is not to be considered as a decomposition."

Then the subject of meat is taken up. "Although man emerged from recorded antiquity on a diet consisting mostly of animal products, many persons think that meat food is harmful." But examinations of numerous races have shown that "the carnivorous diet, when adequately supplemented with those nutritional factors which may be lacking, produced robust and healthy people." Dr. Shrader believes that one of meat's great values is "its flavor and gustatory appeal." The nutrition value of poultry is given in a table in which six different kinds are compared.

The interesting chapter on eggs will be enjoyed by all teachers of health and nutrition. Candling, cleaning, "treating" or preserving, freezing, and drying processes are described. The caloric comparison between a pound of eggs and an equal weight of meat is helpful as is also the comparison between egg yolk and cod liver oil in vitamin D content. The reason why eggs not kept cool may become a health hazard has been clearly stated.

In the chapter on fish, the author tells how several investigators have shown the digestibility of sea food in comparison with that of meat. This clears up a question which is often asked. In defense of bread Dr. Shrader refers to the so-called "Oslo breakfast" and its nutritional benefits. The subject of irradiated cereals is presented from the viewpoint of the Council on Foods of the American Medical Association. Seventeen breakfast foods are analyzed for composition and caloric value.

How are various kinds of flour prepared? How are the different breads made? How is insecticide-sprayed fruit made safe for the consumer? What do fruits and vegetables lose of their health value during transportation? What are the "protective foods"? Will the green part of potato cause illness? Will dyed oranges cause dermatitis?

These are only a few—a very few—of hundreds of health questions answered in *Food Control*. Canning, drying, refrigeration, and other methods of food preservation and the effects they have upon nutrition and health are authentically described and indicated here.

The highlights of the Federal Food and Drug Act follow the "Equivalence

of Vitamin Units" and precede a quite complete index.

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THE BARNES DOLLAR SPORTS LIBRARY. (New York: A. S. Barnes and Co.) each volume $1.00.

Many new volumes have been added to this popular sports library, which now covers more than twenty sports. Following, some of the recent additions are reviewed briefly.

ARCHERY. Natalie Reichart and Gilman Keasey. (95 pages.)

The authors have included new material in this addition to bring the book up to date. The "relaxed method" is given credit for tournament successes. Much attention is given to the use of this method throughout the book for the beginner and expert alike. It is divided into the following chapters: The Relaxed Method, Archery Equipment for Target Shooting, Care of Equipment, Teaching an Archery Group or Class, Archery Competition, Indoor Archery.

BOXING. Edwin L. Haislet. (118 pages.)

Basic boxing skills are emphasized and are discussed under the following headings: The Fundamental Position, The Art of Hitting, Fundamental Blows and Blocks, Fundamental Footwork, The Advanced Blows and Blocks, The Elements of Defense, The Elements of Attack, The Counter Attack, Setups, Ring Craft and Ring Generalship, How to Train for Boxing.

Ninety-six figures show the proper boxing positions. The last chapter includes first-aid treatment for injuries.

LACROSSE. Tad Stanwick. (94 pages.)

Lacrosse has become increasingly popular in our schools and colleges and this book answers the need for authoritative information. The book is divided into chapters on: History of Lacrosse, The Game, Definitions of Terms, Stick Handling, Team Play, Coaching Lacrosse, Equipment and Sample Plays.

The author develops a definite system based upon the fundamentals of the game and covers every aspect of the game in detail. He analyzes carefully the situations that occur in play and uses both illustrations and diagrams to qualify the text.

RIDING. Col. J. J. Boniface. (86 pages.)

The basic fundamentals of good riding for beginner and expert are presented in this authoritative book. Essential points which must be learned and mastered are described in simple and interesting language. The author has a deep love for horses, born of many years of experience in the saddle. The book is divided into the following chapters: Initial Training of Horse and Rider, Riding at the Walk and at the Trot, Riding at the Lope, Canter, Gallop, and Run, Riding on the Open Range, Riding at the Artificial Gaits, Riding Over Jumps and Riding Bucking Horses, The Elements of Rough-Riding, Polo Playing, Endurance Riding, and Famous Rides, Questions and Answers for the New Rider.

ROPING. Bernard S. Mason. (138 pages.)

Bernard S. Mason, Editor of *The Camping Magazine*, gives us this book covering the techniques and fundamentals of roping and rope spinning which have always caught the imagination. Little has been written about this colorful and fascinating sport. The author divides the book into the following chapters: Ropes and Roping, The Flat Spins, The Vertical Spins, Trick Knots with a Lariat, Lariat Throwing, Roping Exhibitions and Contests.

Roping is essentially a one-man sport and all the equipment you need is a rope. Once you get the roping fever you will find it hard to shake.

SIX-MAN FOOTBALL. Ray O. Duncan.

This text is written particularly for the coach who has had little or no experience in football, and for this reason it will undoubtedly satisfy the needs of many tutors in small schools where six-man football is coming into its own. The discussion is wisely limited to the fundamentals of tackling, blocking, passing, kicking, and running.

In addition to chapters on the above aspects of the game, there are chapters on defense, offense, training, and administration.

BASKETBALL FOR GIRLS. Wilhelmine E. Meissner and Elizabeth Yeend Meyers.

This volume is a revision of an earlier work on the subject by the same writers. While the emphasis is placed on material that will be helpful to coaches, the book will also find use by the players. Playing techniques are fully described.

The chapters cover the subjects of: History, Equipment, Teaching of Basketball, Catching and Passing, Individual Techniques or Tactics, Shooting, Offense, Defense, Officiating.

FENCING. Joseph Vince.

The extent to which this volume covers fundamentals of fencing is best indicated by listing the chapter headings. For the section on the foil, they are: Grip, Initial Position, Salute, On Guard, Footwork, Hand Positions, Target, Guard Positions, Attacks, Parries, Ripostes, Redouble, Timing, Boutwork, Exercise, and Target Practice. For the épée, the chapters are: Grip, Guard Position, Attacks, Parries, Boutwork, Exercises, and Electric Épée. Saber: Grip, Positions, Whirl, Target, Attacks, Parries, Ripostes, Boutwork, and Exercises.

BOWLING. Joe Falcaro and Murray Goodman.

In this volume, the world's undefeated match game bowling champion (Falcaro) describes the fundamentals and principles of "championship" bowling. In addition to the sections one would expect on delivery, direction and speed, etc., there are chapters devoted to etiquette, to games similar to but different from regular bowling, and to teams, leagues, and tournaments. The official bowling rules are also included.

SOFTBALL. Arthur T. Noren. (108 pages.)

Softball interpretations of the rules together with the official rules for 1940 are included in this volume. The author has compiled a complete handbook outlining the techniques of the game and describing each position. He then outlines the fundamentals of batting, base running, and team play. Valuable information on equipment, layout of the diamond, and construction of backstops and bleachers is added.

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